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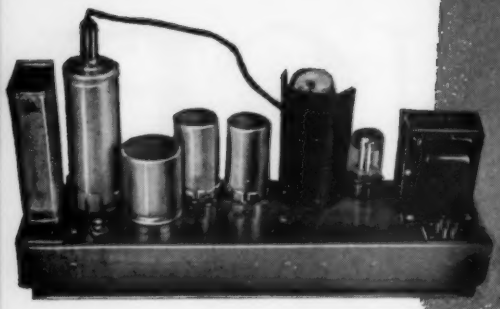
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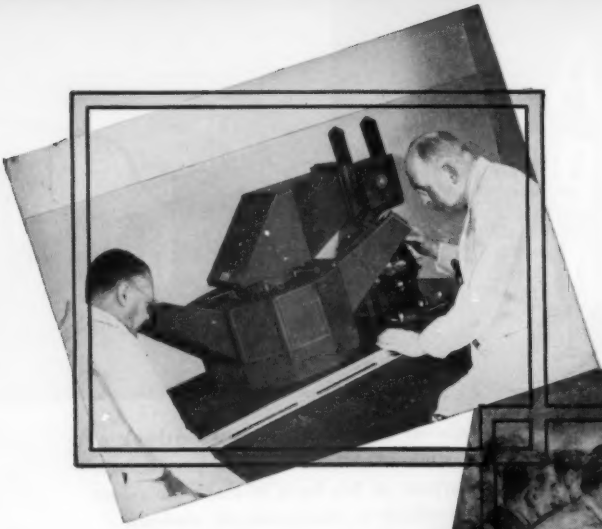
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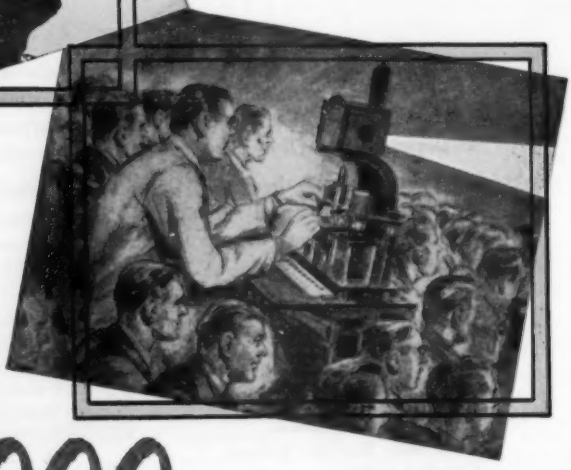
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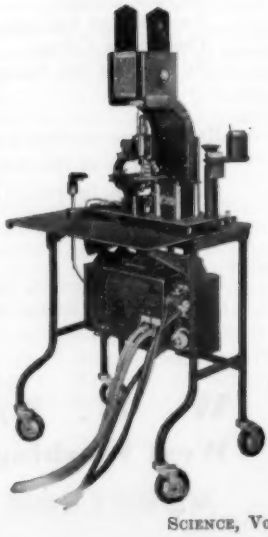


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Coal Research

THE increasingly voracious appetite of the organic chemicals industry requires that increasing scientific attention be devoted to the largest stockpile of carbonaceous material available—the huge reserves of coal still buried beneath the soils of America. The chemicals available as by-products from the conversion of coal to coke for the steel industry must necessarily remain restricted in quantity, since large increases in the tonnage of steel production do not appear imminent. The mandatory development of other processes for the production of chemicals from coal has been severely handicapped by a critical lack of fundamental information concerning the chemical and physical structure of coals and their degradation products.

In 1928, in his address of welcome to the second International Conference on Bituminous Coal, the late Thomas S. Baker stated that "in Pittsburgh we should have a great research establishment for the study of coal—one which should employ not only the services of men who are striving to perfect the processes which have already been thought of, but also men who occupy themselves with the basic conceptions of physics and chemistry, and who see in a lump of crude bituminous coal an opportunity of finding an answer to some of the enigmas of nature." Pursuing vision with initiative, Dr. Baker, then president of the Carnegie Institute of Technology, established the Coal Research Laboratory with the dual objectives "to do fundamental research in coal and derived products" and "to train students in coal technology."

In the twenty-two years since it was founded, the Coal Research Laboratory has become one of the world's most important centers of coal research. It has actively pursued fundamental investigations on the mechanism of thermal decomposition of coals and of their chemical structure, as elucidated by studies of the primary thermal decomposition products obtained at low pressures, of the action of solvents over a wide range of temperatures, and of the chemical structures of the products resulting from controlled breakdown of coals by oxidation, hydrogenation, and halogenation reactions.

As a logical extension of the fruitful studies of oxidation, a pilot plant was developed to evaluate costs, compile data, and investigate potential uses of the organic acids produced directly and readily by oxidation of coals.

Work on coal hydrogenation, which was started in 1932, has helped to interpret the general mechanism of the hydrogenation reaction and to determine the yields and the nature of the intermediate products. Additional studies on the mechanisms and techniques of gasification and combustion reactions and on methods of coke evaluation, statistical analyses of published data, and reviews of current literature have helped to eliminate serious gaps in our basic knowledge of coals and their uses.

The sum total of basic information accumulated in this and other laboratories of the world has accumulated to the point where the direct production of chemicals from coal will soon be a commercial reality. In this respect the most significant development has been the recent disclosure that the Carbide and Carbon Chemicals Corporation has constructed a pilot plant for the hydrogenation of coals to chemicals. The signal success of this giant of the chemical industry in previous ventures bespeaks excellent chances of financial success in this one. Even more important, it presages a diminishing reluctance on the part of the rest of the chemical industry to support and actively to pursue research on coal. It remains axiomatic that the more we know about coal, the more we shall do with it.

CLARENCE H. RUOF

Coal Research Laboratory, Carnegie Institute of Technology

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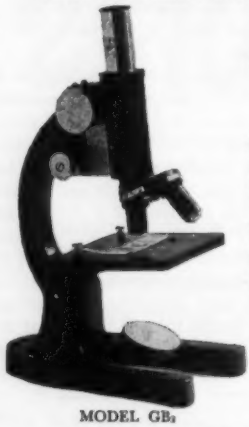
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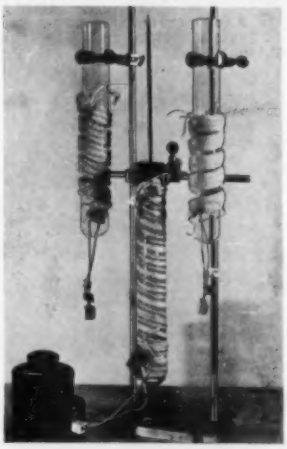
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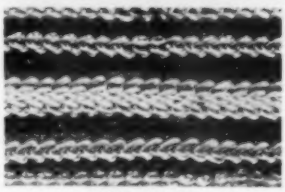
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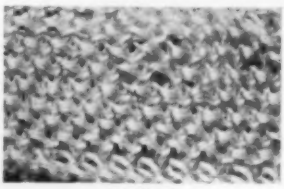
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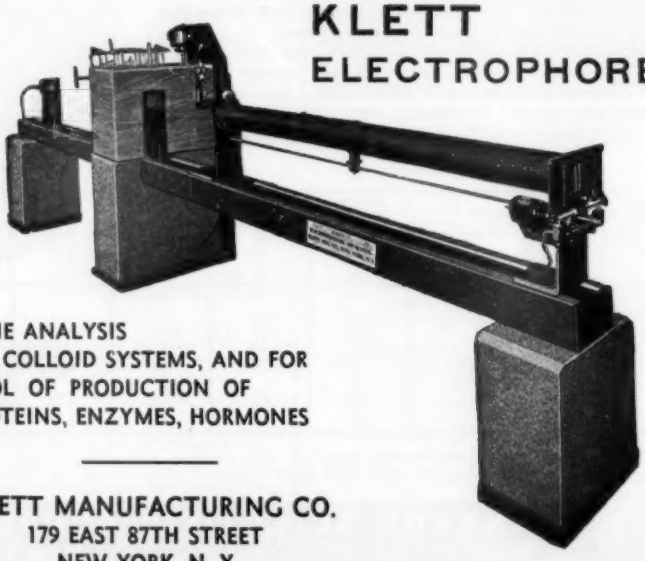
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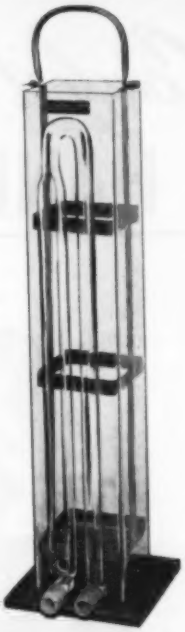
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Electron Microscopy of Ultrathin Frozen Sections of Pollen Grains

H. Fernández-Morán and A. Orville Dahl[1]

Institute for Cell Research, Karolinska Institutet, Stockholm, and *Department of Botany, University of Minnesota, Minneapolis*

RELIABLE ANALYSIS of the ultrastructure of cells and tissues by means of the high resolving power (ideally of about 10 A [*1*]) of the electron microscope can only be carried out on extremely thin preparations—i.e., below 0.2 μ in thickness. Most previous investigations of sections of plant cells with the electron microscope (*2–7*) were performed on material embedded in celloidin-paraffin, in paraffin-wax, or in methacrylate plastic, and then usually sectioned thinly according to the techniques developed by Pease and Baker (*8*) or by Newman, Borysko, and Swerdlow (*9*). Embedding of such cells involves the usual dehydration and infiltration with organic solvents, followed by impregnation with the aforementioned embedding media—procedures that can obscure fine detail in the sections. The removal of the embedding media from the thin sections can also introduce change or distortion (*10*).

One of us (Fernández-Morán, *11–13*) has developed a method for obtaining ultrathin frozen sections of unembedded, fixed material without preliminary treatment. In a number of cases where comparison with collodion-paraffin– and methacrylate–embedded sections was possible, especially in the study of nerve fiber ultrastructure and of bacteria sections (*14*), the frozen sections have proved either equal or superior to the embedded material in revealing delicate structural details. Parallel studies with phase contrast microscopy can also be readily made with the frozen sections.

The present communication summarizes the application of this freezing, sectioning technique to a preliminary study of the mature pollen grain wall.

Pollen of *Tradescantia paludosa* E. Anders. & R. E. Woodson (University of Minnesota, Clonal Line 6–50) was utilized. The mature pollen grains from recently dehisced anthers were fixed in freshly prepared Navashin-Karpechenko[2] and Champy (*15*) fluids for 12–24 hours. The fixation vials were evacuated for 2–5 minutes after the introduction of the pollen material and were maintained at refrigerator temperatures. The fixed pollen grains were washed in distilled water and were then collected, by centrifugation or filtration, on small disks of filter paper. The disk with the wet sediment of pollen grains was frozen on the special stage of the freezing microtome assembly (*12*) attached to the specimen holder of a Spencer rotary microtome, Model No. 820, equipped with an electric motor drive to deliver 50–100 rpm. The well-frozen, fixed pollen was then advanced until it came in contact with the knife edge, and several sections, 1 μ in thickness, were cut and floated off on the surface of the water reservoir attached to the knife. Both ordinary (Schick) razor blades fitted in a special knife holder and the excellent glass knives described by Latta and Hartman (16), but prepared by thermal cracking, were used.

Sections thin enough for electron microscopy (0.1–0.2 μ) were then obtained by disengaging the mechanical advancing system of the microtome, thus permitting the continuous thermal expansion of the stage to advance the specimen toward the knife edge by fractions of a micron with each cutting stroke. The sections of the pollen grain spread out immediately upon hitting the water surface, forming a practically invisible thin film. The sections were picked up directly by lowering collodion-covered electron microscope grids parallel to the water surface until they touched the sections, which immediately adhered to them. The sections can also be picked up on glass cover slips coated with a thin collodion film, which can be peeled off afterward for electron microscopy. The latter method is more convenient for examination of the sections with the phase contrast microscope (Zeiss). The sections may be either frozen-dried by placing the grids on a brass block cooled to −50° Celsius or air-dried. The block was transferred to a vacuum evaporation chamber, placed on insulating glass plates, and a vacuum drawn. The sections may then be shadowed with platinum/palladium and reinforced with a vertically deposited aluminum film.

Knife-tilt, meniscus level of the collecting reservoir, consistency of the specimen, variable mechanical factors in the microtome, and motor drive are all critical factors. The method is actually simple and gives dependable results in routine practice. An RCA type EMU electron microscope with a saturated emission type electron gun (accelerating potential, 50 kv), and equipped with RCA telescopic image viewing device and a compensated objective, was used throughout this study.

[1] Grateful acknowledgment is made to T. O. Caspersson, Director of the Institute for Cell Research, and to Arne Engström for research facilities.

[2] Ten ml 1% chromic acid, 4 ml 16% formaldehyde, 1 ml propionic acid.

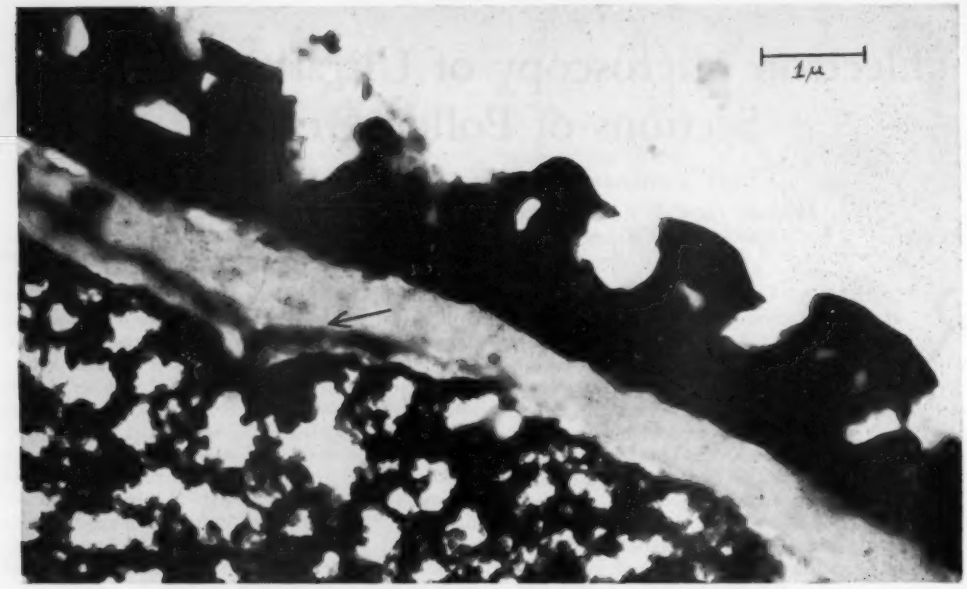


FIG. 1. *Tradescantia*: Wall and contiguous protoplast of mature pollen grain. Frozen section of unembedded, fixed (Navashin-Karpechenko) material; thickness, *ca.* 0.2 μ. Electron micrograph: RCA EMU electron microscope. 50 kv. × 16,000.



FIG. 2. Same as Fig. 1, except thickness of section, *ca.* 0.1 μ. Portion of exine showing columellate-tectate structure.

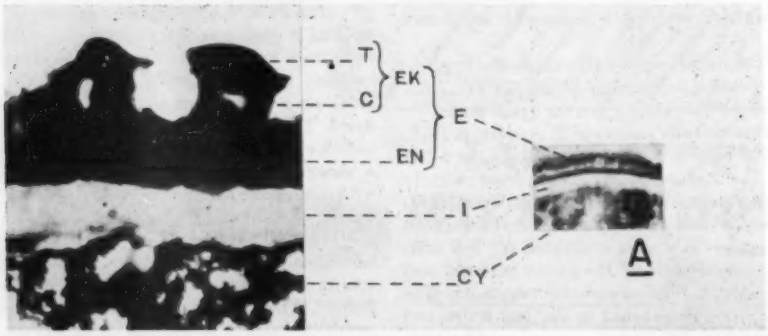


FIG. 3. Summary of structural relationship of components of mature pollen grain of *Tradescantia*: tectum (*T*), columellae (*C*), ektexine (*EK*), endexine (*EN*), exine (*E*), intine (*I*), and cytoplasm (*CY*). *A*, Phase contrast (Zeiss) picture. 1 μ, frozen section of unembedded, fixed material. × 1800.

There are conflicting reports in the literature concerning the relative merits of various fixatives for electron microscopy (*cf. 4, 17–20*). In the limited study reported here, both fixatives were similar in

preserving details of the pollen grain wall. Champy fixation, however, demonstrated a much finer texture in the cytoplasm than did Navashin-Karpechenko fixation, although some variation in texture was evident within the protoplast.

Most pollen grains possess a complex wall which, on the basis of visual light microscopy, has been divided into an outer layer or zone, the exine, which itself may be further subdivided; and an inner layer, the intine. The most illuminating recent studies of sectioned exine are those of Christensen (*21*) and Iversen and Troels-Smith (*22*), which are based upon visual light microscopy of thin (1 μ) sections of acetolyzed pollen grains. The present findings are in harmony with these reports. The exine and intine of the *Tradescantia* pollen grains are vividly differentiated by electron microscopy (Fig. 1). The exine is a highly resistant layer, heavily charged with a variety of largely unknown compounds that apparently render the exine very opaque to electrons. Thus in Figs. 1–3 the exine appears dark in contrast to the light intine. As viewed in transverse section, the only exine components resolved by electron microscopy are the discrete columellae, the smallest of which observed are about 0.12 μ in diameter. Their mean diameter is *ca.* 0.2 μ. Usually adjacent columellae are coalescent at their more or less enlarged tips, giving rise to groups of variable lateral extent (Fig. 2). In transverse section the effect is that of a canopy, or tectum, supported by the columellae. In the case of *Tradescantia* this tectum exhibits an irregular discontinuity (Figs. 1, 2), which accounts for the areolate or rugulate character of the exine as observed in surface view with visual light microscopy. The total radial extent (i.e., thickness) of the entire exine layer averages 1.43 μ. This layer is subdivisible into a centripetal layer *ca.* 0.62 μ in thickness, the endexine, from which the columellae extend centrifugally. The discrete columellae have a radial extent (i.e., length) of *ca.* 0.40 μ and the tectum is *ca.* 0.41 μ in thickness. Columellae and tectum together represent the ektexine (Fig. 3).

The intine, a layer *ca.* 0.79 μ in thickness, is readily penetrated by electrons. It lacks the highly resistant properties characteristic of exine. A relationship of fundamental importance is that existing between the wall of the pollen grain and the protoplast. In terms of physical intimacy this may be expressed as the relationship between intine and cytoplasm. Inspection of the original electron micrographs suggests that the intine of the *Tradescantia* pollen grain is a structure which is penetrated by irregular, rather sinuous strands that appear to be intimately associated with peripheral cytoplasm (note arrow in Fig. 1). In some preparations, the intine has the appearance of a complex system of channels permeating a relatively smooth matrix. The most massive of the strands noted have a diameter of about 0.2 μ.

The above interpretation of intine structure is being followed ontogenetically. In totally different examples, such as the growing wall of the alga *Valonia*, it has been suggested that there is no sharp differentiation between protoplast and wall, and that a protoplasmic component must permeate the latter (*23*). Preston and Wardrop (*24*) have suggested the possibility that in cambial cells there is a ramifying relationship between cytoplasm and the growing wall. An intimate connection between protoplasm and the developing layers of plant cell walls has also been postulated by Mühlethaler (*25*).

The technique described above demonstrates in the pollen grain of *Tradescantia* the columellate, tectate type of exine which has been clearly illustrated with visual light microscopy in a number of dicotyledonous species (*21*). The columellae grade down in diameter to *ca.* 0.1 μ, with a minimum intercollumellar distance of *ca.* 0.06 μ. In the case of the intine, the possibility of an intimate, interpenetrating association with cytoplasm is suggested.

References

1. Drummond, D. G. *J. Roy. Microscop. Soc.*, Ser. III, **70**, 1 (1950).
2. von Ardenne, M. *Z. wiss. Mikroskop.*, **56**, 8 (1939).
3. Elvers, I. *Arkiv Botan.*, **30** B, 1 (1941).
4. Bretschneider, L. H. *Proc. Koninkl. Nederland. Akad. Wetenschap.*, **53**, 1476 (1950).
5. Baker, R. F., and Pease, D. C. *Nature*, **163**, 282 (1949).
6. Rozsa, G., and Wyckoff, R. W. G. *Biochim. et Biophys. Acta*, **6**, 334 (1950).
7. Sedar, A. W., and Wilson, D. F. *Biol. Bull.*, **100**, 107 (1951).
8. Pease, D. C., and Baker, R. F. *Proc. Soc. Exptl. Biol. Med.*, **67**, 470 (1948).
9. Newman, S. B., Borysko, E., and Swerdlow, M. *Science*, **110**, 66 (1949).
10. Hillier, J., and Gettner, M. E. *Ibid.*, **112**, 520 (1950).
11. Fernández-Morán, H. *Exptl. Cell Research*, **1**, 143 (1950).
12. ———. *Ibid.*, 309.
13. ———. *Ibid.*, **2**, 282 (1952).
14. ———. *Arkiv Fysik*, **4**, 471 (1952).
15. Romeis, B. *Mikroskopische Technik*. München: Leibniz (1948).
16. Latta, H., and Hartmann, J. F. *Proc. Soc. Exptl. Biol. Med.*, **74**, 436 (1950).
17. Porter, K. R., Claude, A., and Fullam, E. F. *J. Exptl. Med.*, **81**, 233 (1945).
18. Claude, A., and Fullam, E. F. *Ibid.*, 51.
19. Wyckoff, R. W. G. *Electron Microscopy*. New York: Interscience (1949).
20. Rozsa, G., Szent-Gyorgyi, A., and Wyckoff, R. W. G. *Exptl. Cell Research*, **1**, 194 (1950).
21. Christensen, B. B. *Medd. Dansk Geol. Foren.*, **11**, 441 (1949).
22. Iversen, J., and Troels-Smith, J. *Danmarks Geol. Undersøgelse*, Ser. IV, **3**, 1 (1950).
23. Wilson, K. *Ann. Botany*, **15**, 279 (1951).
24. Preston, R. D., and Wardrop, A. B. *Biochim. et Biophys. Acta*, **3**, 549 (1949).
25. Mühlethaler, K. *Ibid.*, **5**, 1 (1950).

George Walter McCoy: 1876—1952

Charles Armstrong

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WITH THE DEATH of George Walter McCoy on April 2, 1952, the United States Public Health Service lost one of its most respected and distinguished officers. Born in the Cumberland Valley, Pennsylvania, in 1876, Dr. McCoy received his medical degree from the University of Pennsylvania in 1898, and entered the U. S. Public Health and Marine Hospital Service in 1900. His early investigations dealt with plague, leprosy, and the natural diseases of rodents. Among the latter he recognized a plaguelike disease from which he isolated and cultivated, with C. W. Chapin, the causative organism of tularemia.

Dr. McCoy's work in these fields was widely recognized and led to his appointment as director of the Hygienic Laboratory (which later became known as the National Institutes of Health), a position he held for 23 years. Under his leadership the laboratory grew in scientific prestige and expanded from the single "red brick building" to four excellent buildings, wherein the enlarged staff found improved facilities, at 25th and E Streets, Washington, D. C. The institute was later transferred to Bethesda, Maryland.

After becoming director Dr. McCoy, in addition to his administrative duties, found time to continue research and field studies on such problems as leprosy, dengue fever, influenza, psittacosis, post-vaccination tetanus, antirabies vaccination paralysis, amebic dysentery, biologics control, etc. He was a strong advocate of a combined field and laboratory approach to disease problems, and his contributions to both epidemiology and laboratory knowledge were substantial. His publications were models of directness, conciseness, and clarity.

His scientific opinions and advice were much sought; yet perhaps his greatest contribution to science came from his unique method of handling students and young scientists. In order to appreciate his methods and to judge the full impact of his influence, one must understand the character and personality of the man.

In scientific matters Dr. McCoy was an austere critic, yet always kind, fair, self-effacing, and loyal. As director of the laboratory he considered himself to be the servant rather than the master of the bench workers. In the atmosphere of his laboratories it was easy for the investigator to become absorbed in his problems; and when he was once interested, he was allowed free rein to follow his own ideas, leads, or hunches, without restraint or questioning. The director never pressed an investigator for early publication; in fact, he was more likely to advise "more study before going on record." Yet he considered the investigators' time as almost sacred and was resentful whenever administrative or other matters distracted them from their problems.

Among the small, devoted group of scientists privileged to enjoy his stimulating influence were Joseph Goldberger, Edward Francis, James P. Leake, R. R. Parker, Charles Armstrong, R. R. Spencer, Ida Bengtson, Alice Evans, R. E. Dyer, Kenneth Maxey, and R. D. Lillie.

Perhaps the personal quality that best characterized Dr. McCoy was his downright honesty. He was ever ready to acknowledge when he did not know, or to admit an error, or to change his opinion in the face of evidence; but otherwise he could not be coaxed or cajoled to do so. It was quite natural for him in a research institution to place research above all else—he cared little for a fine "mill," but he cared everything for the "grist." He would readily approve expenditures for research necessities, but he would permit no luxuries such as rugs, fine desks, fancy furniture, or paintings in his own or other offices. Some smiled at these "peculiarities," but they were a natural and necessary result of his stern sense of propriety.

Dr. McCoy was appointed professor of preventive medicine and public health in the School of Medicine, Louisiana State University, in 1938 and served until 1945. He filled the position with distinction through mastery of the subject field, ability to go directly to the heart of a problem, and a manner of expression that was simple, concise, and direct.

For his contributions to public health George W. McCoy was awarded the Sedgwick Gold Medal by the American Public Health Association in 1931. He served on the National Board of Medical Examiners, 1921–40; the Basic Science Board for the District of Columbia; the Council on Pharmacy and Chemistry of the American Medical Association; the Committee on Biologic Products of the U. S. Pharmacopeia; and on the Committee of Virus Research and Epidemiology of the National Foundation for Infantile Paralysis. He was a member of the Society of the Sigma Xi and many professional societies and associations.

George W. McCoy was a great man, an able investigator, a foresighted administrator, an inspiring teacher, and an unimpeachable government official, who by his versatility contributed much to the health of the world.

News and Notes

Royal Society of Canada, Section III

SECTION III, Chemical, Mathematical and Physical Sciences, of the Royal Society of Canada, held its annual meeting at Laval University, Quebec, on June 2–4. G. Herzberg gave the presidential address on "Forbidden Transitions in Diatomic Molecules." This was one of three papers in a symposium on forbidden transitions. The others were "Forbidden Transitions in Atoms," by A. G. Shenstone, and "Forbidden Transitions in Nuclei," by L. G. Elliott. About 100 papers were presented before the subsections—Chemistry, Mathematics, Astrophysics and Spectroscopy, Nuclear Physics, Meteorology, and Other Branches of Physics.

Chemistry. The program of the chemistry subsection consisted of a series of papers in organic chemistry (P. E. Gagnon *et al.*) and several in physical chemistry. The photolysis of azomethane has been investigated over the temperature range 25°–190° C (M. H. Jones and E. W. R. Steacie). Experiments on the photolysis of deuterated methylamines have shown that both the C—H and N—H bonds are ruptured (J. S. Watson and B. deB. Darwent). Various forms of deuterated pentanone-3 have been synthesized (L. C. Leitch and A. T. Morse), and the assignments of certain infrared absorption bands between 1350 and 1475 cm^{-1} to the bending vibrations of the C—H bonds of methyl and methylene groups located at specific positions in the molecule have been confirmed in forms of deuterated pentanone-3 (B. Nolin).

Mathematics. Three papers were read in algebra and number theory, eight in analysis, and two in geometry. The significance of the work presented and the general interest and enthusiasm made this meeting the most outstanding of any yet held by the mathematics subsection. It was generally agreed that the upsurge of activity on the part of Canadian mathematicians is due to the stimulus of the biennial seminars of the Canadian Mathematical Congress and especially to the influence of the Summer Research Institute.

Astrophysics and Spectroscopy. The astronomical papers included the determination of the masses of eclipsing binaries, the study of interstellar matter, the investigation of the line profiles of Be-type stars, and the development of new techniques for the determination of time. The orbital elments of the exceptionally massive eclipsing system, H.D. 228854, have been deduced (J. A. Pearce). These stars are of spectral class O 7 with temperatures of 33,000° K. The orbital inclination is nearly 90°, and the relative orbital velocities are exceptionally large, 710 km/sec. The combined mass is 70 times the sun. A new catalogue of 1346 variable stars in globular clusters has been prepared (Helen S. Hogg). Investigation of the absorption lines of the eclipsing stars Zeta Aurigae when light of the hot star traverses the atmosphere of the larger and cooler companion has provided evidence of major prominence activity of irregular character (A. McKellar and R. M. Petrie). The intensities of interstellar sodium and calcium lines for 142 early type stars have been used to derive a relation between distance and intensity (C. S. Beals).

Relatively high dispersion spectra of the aurora have been obtained in the region 3300–8900 A (W. Petrie). The near-ultraviolet emission bands of the N_2^+ molecule support the value 9.75 ev for the dissociation energy (A. E. Douglas). The rates of change of polarizability with respect to internuclear distance have been found from the ratio of the intensities of Raman and Rayleigh scattering in gases (E. J. Stansbury, H. L. Welsh, and M. F. Crawford). Experimental and theoretical results on the splitting of nuclear magnetic resonance absorption lines in single crystals by the interaction of the nuclear electric quadruple moment with the electric field gradient within the crystal were reported (G. M. Volkoff).

Nuclear Physics. A varied program of nuclear physics papers on heavy cosmic primaries in photographic emulsions, photonuclear reactions, neutron physics, radioactive nuclides, and mass spectrometry was presented.

Several papers on neutron physics from the Chalk River Laboratory will be briefly reviewed. Work on the resonant scattering of slow neutrons by Sm, Gd, Eu, Dy, and Cd was reported. The scattering and total cross sections of Cd in the resonance region accurately obey the Breit-Wigner one-level formulas. The total cross section at resonance is 7900 barns (B. N. Brockhouse). The neutron capture γ-ray spectra from the even-charge nuclei Ti, Cr, Fe, Ni, and Zn, and from the odd-charge nuclei Sc, Mn, Co, and Cu, were shown and discussed in terms of nuclear shell theory (B. B. Kinsey and G. A. Bartholomew). The angular distributions of prompt fission neutrons with respect to the direction of motion of the light and heavy fragments from the thermal neutron fission of U^{233}, U^{235}, and Pu^{239} show that the neutron emission probability is 30% greater for the light fragment (J. S. Fraser and J. C. D. Milton). The neutron capture cross section for Co^{59} (n, γ) Co^{60m} (10.7 min) was reported as 19 barns (N. Moss and L. Yaffe). The nuclide Ra^{227}, produced by the Ra^{226} (n, γ) Ra^{227} reaction with a cross section of 22 barns, is a β-emitter with a half-life of 41.2 min, a maximum energy of 1.30 mev, and γ-rays of approximately 291 and 497 kev (J. P. Butler and J. S. Adam. A curious time behavior of positrons annihilated in liquids and solids was reported. In metals and several other materials, positrons are annihilated with a single mean lifetime of about 2×10^{-10} sec. In other materials (e.g., water, ice) two distinct lifetimes were observed—about 3×10^{-10} sec and 2×10^{-9} sec (R. E. Bell and R. L. Graham).

Papers on the radioactive properties of neutron-deficient nuclides, Cd^{106}, Cd^{104}, Ag^{104}, Xe^{123}, Xe^{122},

and Xe^{121}, produced by proton bombardment in the McGill University cyclotron, were read (J. S. Foster, F. A. Johnson, and D. E. Tilley). The x-rays from the 70 mev synchrotron at Queen's University have been used to study depth-dose relations in a Plexiglas phantom, the absorption of 17.5 mev x-rays in various absorbers with the aid of Cu^{63} (γ, n) Cu^{62} as detector, and the production and cross sections of photonuclear reactions such as the (γ, n) reactions in C^{12}, Cu^{63}, Ag^{107}, and Mo^{92}, and the reactions C^{12} (γ, 3α), and O^{16} (γ, 4α) (J. A. Gray *et al.*). The 25 mev betatron at the University of Saskatchewan can be held constant to 5 kev at a preselected energy. Photoactivation curves have been obtained that show a fine structure attributed to absorption by individual levels in the reacting nucleus. The ratios of the cross sections for the (γ, n) reactions leading to the ground and isomeric states in Br^{80} and Mo^{91} have been measured and related to the spins of the reacting particles (L. Katz, R. N. H. Haslam, *et al.*). Excellent agreement with experimental results on the capture of electrons by protons in hydrogen is obtained if both the ion-nucleus interaction and the electron-ion interaction are included as perturbations in a calculation using the Born approximation (J. D. Jackson and H. Schiff).

Other Branches of Physics. Papers in meteorology included a discussion of the conditions for the production of low-temperature fog (W. L. Godson), a correlation between snow crystal types and the temperature at the height of formation (L. W. Gold and B. A. Power), and evaluation of fluctuating radar weather echoes (J. S. Marshall and W. Hitschfeld). A method for measuring subsurface velocities in the Gulf Stream was described (E. E. Watson). A flowmeter, utilizing the cooling of a thermistor element, has been found suitable for measurement of small velocities in liquids (A. D. Misener).

Several papers were presented on the properties of dielectrics, theory of diffraction, sound sources, vibration of plates, infrared detection, and an absolute measurement of the ohm. The failure of the Clausius-Mosotti equation for certain artificial dielectrics was explained in terms of the random distribution and shape of the metallic particles (H. E. J. Neugebauer). Discrepancies between diffraction theories and measurements close to a circular aperture under the influence of a plane acoustic wave have been traced to rapid oscillations in field intensity within the aperture (G. Bekefi). An improved method of calculating the diffraction of electromagnetic waves by small apertures and scattering by small conducting bodies was reported (A. F. Stevenson). Calculations and observations have been made on the vibration patterns of thick barium titanate disks (R. R. Aggarwal and E. A. G. Shaw). The usefulness of physical theory in solving engineering problems was well demonstrated in a study of chopper-type sound sources for foghorns and air-raid sirens (G. L. Thiessen).

Three papers on low temperature and solid state physics were read (D. K. C. MacDonald). With suitable modification of a Collins helium liquefier, continuous measurements of electrical resistances of metals over a wide range of temperature have been made. The variation of characteristic temperature has been examined and carefully compared with the corresponding calorimetric data. The problems of anharmonicity in lattice vibrations and of melting are of particular interest, together with the adequacy or otherwise of the Debye model. The anomalous minimum of electrical resistance found at about 10° K in copper has been systematically investigated with specimens containing controlled small percentages of Sn, Ag, Ni, Pb, Bi, and C. Scattering cross sections can be deduced from the residual resistances.

B. W. SARGENT

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Scientists in the News

E. F. W. Alexanderson, chief engineer of Radio Corporation of America (1920–24), has rejoined the company in the capacity of consultant. He recently retired from General Electric Company following a long period of service.

Leslie R. Angus has been appointed director of psychiatric services and director of the Child Research Clinic at The Woods Schools, Langhorne, Pa.

Robert V. Bartz, of MIT, has been appointed executive director of the Industrial Associates of the California Institute of Technology. The Caltech Industrial Associates, initiated slightly over two years ago, now include 23 member-companies representing oil, aircraft, steel, chemical, and other industries. Each member-company supports the over-all research program of the institute and in return is kept informed on key developments and trends in areas of existing or potential importance to its business.

Nathan Beckenstein, director of Syracuse Psychopathic Hospital for the past two years, has just been transferred to Brooklyn State Hospital as director, succeeding the late **Clarence H. Bellinger.** Appointed to replace Dr. Beckenstein as director of Syracuse Psychopathic Hospital is **Richard F. Binzley,** associate director of Pilgrim State Hospital. Dr. Beckenstein joined the Brooklyn State Hospital staff in 1929, following his internship at Binghamton State Hospital and Jewish Hospital in Brooklyn. He was appointed acting medical inspector for the Department of Mental Hygiene in 1947 and in 1950 he became director at Syracuse Psychopathic Hospital, serving also as assistant commissioner in the department until early this year.

Robert S. Casey, director of research of the W. A. Shaeffer Pen Company, has been elected chairman of the American Chemical Society's Division of Chemical Literature for 1953. He succeeds **Julian F. Smith,** head of the Scientific Information Division, Office of Naval Research, Washington, D. C. **Byron A. Soule,** of the University of Michigan, was chosen chairman-

elect; **Lorna F. Lederman,** of the Monsanto Chemical Company, Dayton, was named secretary; and **Madeline M. Berry,** of MIT, was elected treasurer.

Philip Chasin, of New York, has been named executive director of the American Technion Society. At the same time it was announced that the society would start an international drive for $20,000,000 for the rebuilding of the Israel Institute of Technology in Haifa, to provide a minimum of 600 engineers, architects, and technicians for Israel's program of industrialization and agricultural expansion.

John Cockcroft, director of the Atomic Energy Research Establishment at Harwell, England, recently delivered two special physics lectures at the California Institute of Technology. He spoke on "Research at Harwell" and "Harwell Ideas on Nuclear Power."

C. Henry Kempe, assistant professor of pediatrics in the University of California School of Medicine, San Francisco, has been granted a leave during December and January to accept an invitation by the government of India and the World Health Organization. He will conduct studies on serum treatment of smallpox in connection with research being carried on in the School of Medicine at the King Institute.

H. D. Kerman has returned to his post as associate professor of radiology at the University of Louisville School of Medicine after a two-year leave of absence as radiologist with the Oak Ridge (Tenn.) Hospital and the Medical Division of the Oak Ridge Institute of Nuclear Studies.

Z. I. Kertesz, professor of chemistry, New York State Agricultural Experiment Station, Cornell University, Geneva, has been granted a leave of absence to accept a one-year appointment as director of food research for the United Nations' Food and Agricultural Organization Technical Assistance Program in Ceylon. Dr. Kertesz will coordinate the work of a team of FAO food experts and advise the Ceylon Food Research and Nutrition Council on the establishment of a Food Research Institute.

Anton Lang has joined the faculty of the University of California at Los Angeles as assistant professor of botany. He was formerly connected with the Kaiser Wilhelm Institute of Biology in Berlin and later with the Max Planck Institute in Tübingen. He came to the U. S. in 1949 and for the past two years has been a senior research fellow at California Institute of Technology.

Rachmiel Levine has been appointed to the newly established position of chairman of the Department of Medicine and director of the Educational Program at Michael Reese Hospital, Chicago. The hospital has taken this step in the further development of an integrated training program for internes and residents. Dr. Levine, who has been associated with Michael Reese Hospital since his graduation from McGill University in 1935, is at present the director of the Department of Metabolic and Endocrine Research at the hospital's Medical Research Institute, and also a professorial lecturer in physiology at the University of Chicago.

George H. Mangun has been appointed research director of the Warner Therapeutic Institute and Chilcott Research Division of Warner-Hudnut, Inc. For the past five years he has been head of the Department of Clinical Chemistry of the Henry Ford Hospital, Detroit, and professorial lecturer at Wayne University Graduate School.

The first David Sarnoff Fellowship established at the New York University College of Engineering by the Radio Corporation of America in honor of David Sarnoff, RCA board chairman, has been awarded **Oscar Oliver, Jr.** Mr. Oliver was selected from a class of 256 graduating engineers to receive the fellowship, which provides an annual grant of $2700 for predoctoral study. The award was established this year as part of a program to assist in the education of scientific personnel for leadership in the growing electronics industry.

Maurice L. Peterson, associate professor of agronomy, University of California College of Agriculture, has been named chairman of the Department of Agronomy, succeeding **Fred N. Briggs,** who was recently appointed dean of the College of Agriculture for the Davis campus. Dr. Peterson joined the staff of the university in 1948.

A team of Swedish oceanographers headed by **Hans Pettersson** and **W. Weibull** will continue their research on the sediments of the oceans. Their new expeditionary work will take them into the Mediterranean on board the French vessel *Elie Monnier,* placed at their disposal by the French Navy. The scientists will use the depth-charge echo-sounding methods developed by Dr. Weibull in determining the depth of the sediments resting on the igneous rock.

George H. Plumb, assistant entomologist at the Connecticut Agricultural Experiment Station, has resigned to accept the post of chief of the newly organized Division of Forest Insect and Disease Control of the Virginia Forest Service. His headquarters will be in Charlottesville. Dr. Plumb was with the Connecticut station 21 years.

William J. Simon, professor of dentistry at the University of Minnesota, has been named dean of the college of dentistry at the State University of Iowa. Dr. Simon, who has been on the staff of the Minnesota School of Dentistry since 1936, will take over his new duties at Iowa City on Jan. 1.

Charles E. Sloan, engineer of bridges for the Baltimore and Ohio Railroad since 1940, has been appointed engineer of bridges and buildings, succeeding **Leland P. Kimball,** engineer of buildings, who has retired. Other promotions in the B & O Engineering

Department include **Otis G. Wilbur** and **Abram Clark,** appointed assistant engineers of bridges and buildings, and **Gurney H. Dayett, Sr.,** appointed assistant to Mr. Sloan.

J. McLean Thompson has retired from the chair of botany in the University of Liverpool and has been succeeded by **N. A. Burgess,** of the University of Sydney. Professor Thompson went into botany in the heyday of comparative morphology and, since his appointment to the chair of botany at Liverpool in 1921, has continued morphological work with tropical and subtropical plants, devoting his attention more recently to the complex and enigmatic phenomenon of cauliflory. In these studies he has shown the extraordinary morphogenetic potentiality and diversity of the bud-forming regions of the trunks of various woody species.

Joseph F. van Ackeren has been appointed chief medical officer of the Coast Guard, succeeding **Paul M. Stewart,** who has reached the age of mandatory retirement. Dr. van Ackeren has been medical officer in charge of the U. S. Public Health Service Hospital, Seattle, since 1944.

Channing P. Van Camp, of the Pacific Region, USGS, has been designated assistant to the chief topographic engineer in Washington, D. C. Mr. Van Camp joined the Geological Survey in 1934, becoming assistant Pacific Region engineer in 1947.

U. S. von Euler, head of the Physiology Department at Karolinska Institutet, Stockholm, has been visiting the Army Medical Service Graduate School, Walter Reed Army Medical Center, Washington, D. C., where he consulted with the staff on problems of shock and circulatory hemostasis.

W. Barry Wood, Jr., professor of medicine at Washington University and physician in chief at Barnes Hospital, St. Louis, is traveling in Korea in his capacity as consultant to the Army Medical Service Graduate School, advising on the Army epidemic hemorrhagic fever research project there.

Education

The **University of California** and the **UCLA College of Engineering** are sponsoring a series of 19 lectures on "Modern Physics for the Engineer," to be given on consecutive Monday evenings. The series began on Oct. 20 with an address by L. I. Schiff, of Stanford. Others who will appear in the series include W. A. Fowler, R. V. Langmuir, W. K. H. Panofsky, W. D. Hershberger, C. Kittel, D. T. Griggs, J. L. Greenstein, F. Seitz, J. Bardeen, J. Kaplan and R. E. Holzer, H. P. Robertson, W. Bleakney, S. Ramo, L. N. Ridenour, R. Revelle, J. B. Weisner, R. Weller, and G. T. Seaborg.

The **Duke School of Forestry,** under contract with the Bureau of Ships, is beginning the study of tropical woods that might be used in manufacturing marine plywood. The project will begin with a study of angelique, a wood of French Guiana. Long-range aim of the research is to ensure a continuous supply of marine plywood in case of a mahogany shortage.

Florida State University has promoted Guenter Schwarz to full professor and chairman of the Physics Department, and George L. Rogosa to associate professor. Under a grant from the National Science Foundation, the two physicists will study the anomalous transmission of radiation through single crystals at the Bragg angle. Several graduate research assistantships are available under the grant. Avramy Melvin, formerly at Columbia University, has joined the department as professor of physics.

The **Medical College of Virginia** has appointed Herbert W. Park, III, professor of physical medicine and rehabilitation and director of the Baruch Center of Physical Medicine; promoted Henry G. Kupfert to professor of clinical pathology and chairman of the department; made Miles E. Hench assistant professor of clinical bacteriology; and promoted M. Josiah Hoover and Susanne Hirt to associate professors of orthopedic surgery and applied anatomy, respectively. Everett I. Evans, professor of surgery and director of the Surgical Research Laboratories, is giving the McArthur Lectures at the University of Edinburgh and the Hunterian Oration before the Royal Academy of Surgeons, London. He will also speak before the Swedish Surgical Society and conduct conferences on the treatment of burns in Paris, Liége, Amsterdam, Copenhagen, and Lund. Dr. Evans will return to the U. S. early in November.

Polytechnic Institute of Brooklyn began a series of ten lectures on "Recent Trends and Developments in Polymer Chemistry" on Oct. 18 with a lecture by B. H. Zimm. Subsequent lecturers will be U. P. Strauss (Nov. 1), F. R. Eirich (Nov. 15), H. Morawetz (Dec. 13), W. O. Baker (Jan. 10), M. Szwarc (Jan. 31), G. Oster (Feb. 28), W. H. Stockmayer (Mar. 14), E. J. Hehre (Apr. 18), and T. Alfrey, Jr. (May 9).

Stevens Institute of Technology has promoted Newell O. Mason to professor in the Department of Humanities, and George Johannus Yevick to associate professor of physics. The Stevens Laboratory of Psychological Studies was recently host to a party of six visiting French psychologists who are on a six-week inspection tour of American industries under MSA auspices. Paul Fraisse, Colette Benassy, Suzanne Pacaud, Jean Faverge, Pierre Rennes, and Jean Bonnaire are making the tour.

West Virginia University, through a gift of $7500 from the Hope Natural Gas Co., of Clarksburg, will construct a geology cottage near Alvon, in Greenbrier County. This will enable geology students at the university's Camp Wood to study geologic formations and structures that are the surface exposures of those actually productive of oil and gas from the subsurface elsewhere.

Grants and Fellowships

The **Institute for Advanced Study** School of Mathematics will allocate a small number of grants-in-aid to gifted young mathematicians and mathematical physicists for the academic year 1953–54. Application blanks, returnable by *Jan. 1*, may be obtained from the institute, Princeton, N. J.

National Research Council Fellowships in the Medical Sciences, supported by the Rockefeller Foundation and the Lilly Research Laboratories, are available for 1953–54. They are intended for recent graduates, preferably under 30 years of age. Fellowships in tuberculosis are available under a grant from the National Tuberculosis Association; Oscar J. Balchum and Arthur M. Dannenberg, Jr., were this year's recipients. Other fellowships are those in radiological research, administered for the James Picker Foundation. Deadline for applications is *Dec. 10*. For full information, address the Fellowship Office, NRC, 2101 Constitution Ave., N.W., Washington 25, D. C.

The **National Science Foundation** has approved 52 grants and two contracts (totaling $728,250) in support of basic research in the biological and physical sciences and to support studies and conferences on science and scientific education. Awards went to institutions in 21 states and the District of Columbia, average $6300 per year, and range from six months to three years. Additional proposals are being evaluated.

Meetings and Elections

The **American Society of Plant Physiologists**, Western Section, has elected the following officers: chairman, Moyer D. Thomas, American Smelting & Refining Co., Salt Lake City; vice-chairman, Harlan K. Pratt, University of California, Davis; secretary-treasurer, D. J. Wort, University of British Columbia.

The dates of the New York meeting of the **Committee for the Scientific Study of Religion** (SCIENCE, **116**, 352 [1952]) have been changed from Dec. 26–27 to Dec. 28–29. Details of the meeting may be obtained from J. Paul Williams, Mount Holyoke College.

The **Hawaiian Academy of Science** will hold its 28th annual meeting Nov. 13–14 at Agee Auditorium, Experiment Station, HSPA. The first evening will be devoted to a symposium on Hawaii's resources. Cultivated crops, animal husbandry potentials, and mineral, marine, fresh-water, and forest resources are among the topics to be discussed. A variety of short papers on scientific work in Hawaii will be presented on Nov. 14.

The **International Astronomical Union** held its eighth general assembly in Rome, Sept. 4–13. Approximately 60 American astronomers participated as delegates at large, and seven were officially appointed by the Department of State and the National Research Council to represent the U. S. (J. J. Nassau, secretary and chairman, U. S. A. National Committee; I. S. Bowen; D. Brouwer; C. M. Clemence; F. L. Whipple; G. P. Kuiper; O. Struve, chairman of the delegation). Among the scientific activities of the meeting were four symposia on: stellar evolution, astronomical instruments, a catalogue of positions of faint stars, and the spectra of variable stars. The American contributions included a lecture by I. S. Bowen on the 200-inch telescope; by C. D. Shane on the Lick Observatory program of referring the measured motions of the stars to the system of extragalactic nebulae; by D. Brouwer on the astrometric work of the Yale Observatory; by M. Schwarzschild and J. L. Greenstein on the spectroscopic differences of "old" and "young" stars; by W. Baade on recent Mount Wilson and Palomar conclusions regarding the two stellar populations; by O. Struve on the spectra of the β Canis Majoris variables. Harlow Shapley gave an evening lecture on "Extragalactic Problems." The IAU decided to hold its next meeting in 1955 in Dublin. The newly elected officers for 1952–55 are: president, O. Struve (USA); general secretary, P. Th. Oosterhoff (Netherlands); vice presidents: V. A. Ambarzumian (USSR), A. Couder (France), E. Rybka (Poland), P. Swings (Belgium), R. v. d. R. Woolley (Australia). The outgoing president, B. Lindblad (Sweden) and general secretary, B. Strömgren (Denmark and USA) remain on the executive committee in an advisory capacity.

The following have been named as the 1952 winners of the annual **Lasker Awards** of the American Public Health Association: Brock Chisholm, of Toronto; Howard A. Rusk, of New York; Conrad A. Elvehjem, of the University of Wisconsin; Frederick S. McKay, of Colorado Springs, and H. Trendley Dean, of Washington, D. C. (joint award); and MacFarlane Burnet, of Melbourne. A special award was conferred on Chas.-Edw. Amory Winslow, of Yale, "for more than half a century inspiring and inspired leader, teacher, and exponent of public health for the nation and the world." Individual winners received $1000, and Dr. Winslow received $2500.

The **National Research Council** has appointed George W. Nace, of Duke University, staff assistant to the Division of Biology and Agriculture and to the Committee on Developmental Biology; Milton K. Akers, of the Department of Electrical Engineering at George Washington University, has been appointed assistant executive secretary of the Division of Engineering and Industrial Research.

Chemicals wanted by the **Registry of Rare Chemicals**, 35 W. 33rd St., Chicago 16, include: titanium sulfide; lead zirconate; triethyl aluminum; rubidium chromic sulfate; molybdenum carbonyl; β-aminobutyric acid; 4-aminooxine; divinyl sulfone; 2-amino-5-heptenoic acid; gallocyanine; 1,2,3,4-tetracarboxybutane; 8-methoxyquinoline; 2,4-dihydroxyazobenzene-4′-sulfonic acid; 2-chlorofluorene; chlorogenic acid; coprostane; epicholesterol; indican; thevetigenin; and quercitol.

Technical Papers

Studies on Natural Pollination of *Hevea brasiliensis* in Brazil[1]

H. E. Warmke

Federal Experiment Station in Puerto Rico,[2] Mayagüez

As the result of previous studies on pollination in the Pará rubber tree, *Hevea brasiliensis* (Willd. ex A. Juss.) Muell. Arg., evidence was obtained that natural pollination of this species in Puerto Rico was accomplished largely by midges of the family Heleidae (*1*). The presence of pollen grains on Hevea stigmas was found to be associated with the presence of small insect bristles, also found adhering to the stigmatic surfaces and presumably lost by the pollinating insects. The identity of the pollinating insects was finally established by tracing these bristles to three genera of heleid midges: *Atrichopogon, Dasyhelea,* and *Forcipomyia.*

Through the cooperation of the Division of Rubber Plant Investigations, it was possible to continue these studies in the Amazon region of Brazil. These additional studies seemed desirable in order to determine whether methods of natural pollination in Brazil, where Hevea is native, were similar to those in Puerto Rico, where Hevea is introduced.

The studies in Brazil were conducted at the Instituto Agronomico do Norte at Belém during the first two weeks of July and the first week in August 1951, and during the last two weeks of July at Belterra (the site of the old Ford plantation) some 600 miles up the Amazon from Belém.

In general, Hevea flowers were found to be well pollinated; an average of 68% of all stigmas examined at Belém and 48% at Belterra bore pollen grains. In general, also, the stigmas were adequately pollinated. Since these readings were taken early in the season and usually from flowers that had been open less than 24 hr, they represent minimum pollination percentages and probably not final percentages. This would indicate that the low fertility of Hevea in cultivated plantings in Brazil (as in Puerto Rico) probably is not attributable to a failure of natural pollination.

It soon became evident that heleid midges were also the chief agents of pollination in Brazil. Insect bristles were again found on Hevea stigmas, and from this clue the complete process of pollination was worked out, including several important steps that had not been observed in Puerto Rico.

The midges are barely visible to the naked eye (they are approx 1 mm in length) and are yellowish to dark brown in color. Their flight is zigzag and very difficult to follow. Once the eye is trained, however, the insects may be observed carrying on their pollination activities. They are so numerous that half a dozen may be observed at one time around a single inflorescence. They light on a petal and walk into the flower with their backs toward the anthers or stigma. They seem to be interested in the corolla, or the long hairs with which it is clothed on the inside, rather than in the reproductive structures of the flowers. Individuals have been observed to light on male flowers and to go in and out repeatedly, in an aimless fashion. Such individuals when caught and examined under a dissecting microscope were found to be carrying numerous pollen grains—especially on the antennae, the thorax, and the tops of the wings.

Likewise, the insects have been observed to light on the petals of female flowers and, with their wings toward the stigma, walk into the flower through the narrow opening between the stigma lobes and the corolla tube. They may pass down to the region on the ovary, stay there a short time, and then turn and walk out. One female flower that had been so visited by a midge was taken to the laboratory for examination. It was found to have pollen grains lodged on the edges of the stigma where, presumably, they were deposited as the insect walked past.

The midges were difficult to capture. They fly away rapidly at the least disturbance, but generally will return after a short time. Numerous specimens were finally caught by quickly pinching the corolla closed with thumb and forefinger, after an insect had been observed to enter, and then carefully dropping the entire flower in 70% alcohol. For some reason the method used so successfully in Puerto Rico, of placing an adhesive substance on the petal tips of open female flowers, gave indifferent results in Brazil.

The midges are most abundant and most active for 1–1½ hr after sunrise and for 1–1½ hr at sunset. During the remainder of the day only an occasional individual was observed. Wind or rain was found to discourage their appearance, even at sunrise or sunset. The small size, the similarity in color to petals, and the limited periods of activity probably explain the failure of earlier attempts to identify midges as pollinating agents of Hevea in Brazil.

The midges captured were identified as belonging to four genera of the family Heleidae: *Atrichopogon, Stilobezzia, Dasyhelea,* and *Culicoides.*[3] In the genus *Culicoides,* one specimen of *C. debilipalpis* var. *glabrior* Macfie and one of *C. guttatus* (Coq.) were identified. In the genus *Atrichopogon* four different types (probably species) were observed among 41 specimens. In this genus, however, as well as in *Stilobezzia* (3 specimens) and *Dasyhelea* (2 specimens), species identifications were not possible.

[1] Cooperative investigation with the Division of Rubber Plant Investigations, BPISAE, USDA, Beltsville, Md.

[2] Administered by the Office of Experiment Stations, Agricultural Research Administration, USDA.

[3] Identified by W. W. Wirth, Division of Insect Identification, Bureau of Entomology and Plant Quarantine, USDA, Washington, D. C.

There remains little doubt that members of this family, and of the genus *Atrichopogon* in particular, are responsible for most natural pollination of *H. brasiliensis* in Brazil. It is of interest that members of two of these genera (*Atrichopogon* and *Dasyhelea*) were also identified as among the pollinating agents in Puerto Rico. In Puerto Rico, however, members of the genus *Dasyhelea* were found to be most abundant, whereas in Brazil individuals of the genus *Atrichopogon* were most abundant. This difference in relative numbers of insects is believed to be related to the reduced number of stigmas bearing insect bristles in Brazil. Specimens of the predominant form in Brazil, which is yellowish in color, were found to shed few if any bristles when rubbed over the stigmas of fresh Hevea flowers. The dark form, most common in Puerto Rico, was found to shed bristles readily.

An insect belonging to the family Culicidae, tentatively identified as *Mansonia* sp., may also be responsible for some pollination in Brazil. This insect is somewhat larger than the midges and has wing veins and margins marked by a fringe of scales. These scales, or ones similar to them, have occasionally been found on Hevea stigmas and appear to be associated with the presence of pollen grains.

In Puerto Rico, thrips were found to be the most numerous insects around Hevea flowers and were shown to be agents of pollination, although not as important as the midges. In Brazil, thrips of three different genera (*Frankliniella, Scirtothrips,* and *Heterothrips*[4]) were collected from Hevea flowers. The actual numbers of flower thrips observed in Brazil at the time of these studies were so small, however, that these insects were probably of little or no importance as pollinating agents.

Reference

1. WARMKE, H. E. *Science*, **113**, 646 (1951).

Manuscript received April 18, 1952.

[4] Identified by J. D. Hood, of Cornell University.

The Rate of Endogenous Respiration as Affected by the Oxidation of Exogenous Substrates[1]

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Many manometric data in the literature are corrected on the premise that the endogenous respiration continues as its normal rate during the simultaneous oxidation of exogenous substrates. This assumption, unless valid, may lead to erroneous interpretations, especially in the case of such organisms as *Penicillium chrysogenum* Q-176, which possess a relatively high endogenous respiration as compared to their total respiration with a substrate. Inasmuch as it is impossible to distinguish directly between the oxygen needed for the metabolism of endogenous and exogenous materials, some information on the course of the endogenous respiration can be obtained indirectly by comparing the release of isotopically labeled CO_2 from labeled resting cells in the presence or absence of unlabeled substrates (*1–5*). This approach presupposes (*a*) that CO_2 production is a function of oxygen consumption and (*b*) that $C^{14}O_2$ release is representative of the total endogenous CO_2 production. This preliminary note illustrates some of the difficulties encountered in the use of this method.

Vegetative cells of *P. chrysogenum* Q-176 were grown from a spore inoculum at 25° C in 500 ml Erlenmeyer flasks containing 100 ml of a medium in which acetate was the main source of carbon (*6, 7*); the flasks were agitated on a reciprocating shaking machine, which made 90 4-in. strokes/min. After 42 hr of growth, the cells from 6 flasks were harvested, washed with *M*/15 phosphate buffer (pH 6), and added to a flask of fresh medium that also contained 2.0 mg each of 1-C^{14}- and 2-C^{14}-acetate with specific activities of 1 mc/mM. This flask was placed in a closed system similar to the one described by Martin and Wilson (*8*); air was circulated by a small diaphragm pump and freed of CO_2 by passage through alkali. The cells were allowed to grow for 6 hr, while the system was being shaken on a reciprocating shaker. The cells were then harvested, washed with buffer, minced for 15 sec in a Waring blendor, and diluted with buffer to give a cell concentration of about 2–4 mg (dry weight)/ml. Washing the cells after mincing rather than before had no effect on the results. Two ml aliquots of cells were placed in Warburg flasks containing 0.2 ml of 20% carbonate-free NaOH in the center well (without filter paper), 0.5 ml substrate or buffer in one side arm, and 0.5 ml 72% perchloric acid in the other. The experiment was started by the addition of substrate or buffer to the main compartment and stopped, at desired intervals of time, by the addition of perchloric acid. The temperature used was 30° C, and the gas phase was air. One hour or more after the completion of the experiment the alkali was removed quantitatively from the center wells. $BaCl_2$ was added to the alkali to precipitate the carbonate; the $BaCO_3$ was collected by centrifugation, washed twice with 95% ethanol, and then plated on a microporous disk. The radioactivity on the disk was measured by standard techniques, using a thin mica window Geiger-Müller counter. Counts were corrected, by a graphical method, to the activity at 0 self-absorption (*9*).

Fig. 1 shows the results of an experiment with 0.1 *M* glucose or sodium acetate as substrates; the values are averages from two or more determinations. Although the oxidation of glucose did not affect the rate at which $C^{14}O_2$ was released, the oxidation of acetate eventually suppressed the release of $C^{14}O_2$ almost com-

[1] Supported in part by the Atomic Energy Commission. Presented at the 51st General Meeting of the Society of American Bacteriologists in Chicago (*1*).

[2] Predoctoral fellow of the Atomic Energy Commission.

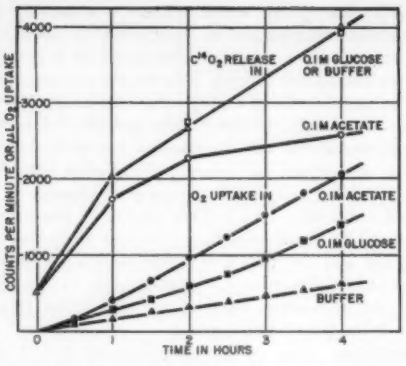


FIG. 1. The effect of glucose or acetate on the uptake of O_2 and release of $C^{14}O_2$ from cells of *P. chrysogenum* Q-176 labeled by growth on 1- and 2-C^{14}-acetate as the main source of carbon. Manometric readings were made every 10 min, but not all of them are recorded.

pletely. These results were observed consistently, even when the cells were labeled by growth on 2-C^{14}-acetate as the main source of carbon rather than a mixture of carboxy- and methyl-labeled acetate.

Parallel experiments using the 2-flask manometric method (*10*) showed that the endogenous RQ was relatively constant over a 4-hr period (0.74 ± 0.04); this fulfills the first prerequisite on which this method is based—namely, that the determination of CO_2 be an indirect measure of the oxygen consumed. However, is the release of $C^{14}O_2$ a true measure of the total endogenous CO_2 released? Inasmuch as the ratio of CO_2/O_2 remained uniform during the experiment, the ratio of $C^{14}O_2$ should also be constant, if this question is to be answered in the affirmative. Fig. 1, however, shows that this ratio became constant only during the last 2 hr of the experiment. This means that $C^{14}O_2$ release could have been completely representative of the total endogenous release of CO_2 only during the second half of the experiment.

The extent to which liberation of labeled CO_2 measures over-all endogenous production of CO_2 depends on the distribution of labeled carbon within the cell. If all cellular components have the same specific activity, the $C^{14}O_2$ evolved will allow a realistic estimate of the total endogenous respiration. If, however, the specific activities of the cellular components vary, the determination of labeled CO_2 may give an incomplete and often misleading picture. This is illustrated by an experiment in which *P. chrysogenum* Q-176 was labeled by allowing the organism, after it had been starved for 2 hr in phosphate buffer at pH 6, to oxidize 2-C^{14}-acetate for 2 hr in the phosphate buffer (Fig. 2). Of the total $C^{14}O_2$ released by resting cells during a 3-hr period, over half was released during the first 30 min. Obviousiy, the $C^{14}O_2$ evolved by cells labeled in this manner was only representative of a small portion of the total endogenous respiration.

The best way to obtain uniformly labeled cells is to use a small inoculum and to grow the cells on a uniformly labeled substrate as the sole source of carbon. When this procedure is applied to microorganisms a good deal of radioactivity is lost in waste products. A less costly way is to allow an already developed culture to continue growing for a limited period of time on uniformly labeled substrates as the sole source of carbon. Whether such cells are homogeneously labeled can then be ascertained according to the criteria already mentioned and also by determination of the specific activities of the cellular carbon and the liberated CO_2-carbon. If the cells are labeled uniformly the specific activities of the cellular carbon and the CO_2-carbon should be the same, and the radioactive CO_2 actually represents the endogenous respiration.

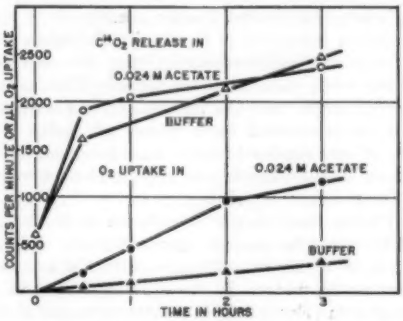


FIG. 2. The effect of acetate on the uptake of O_2 and release of $C^{14}O_2$ from cells of *P. chrysogenum* Q-176 labeled by oxidative assimilation of 2-C^{14}-acetate. Manometric readings were made every 10 min, but not all of them are recorded.

The data in Fig. 1 exemplify the danger of using the total amount of $C^{14}O_2$ released within a given time as an expression of the endogenous respiration. For example, if only single determinations had been made in this experiment instead of kinetic studies, the data might have led, with equal lack of justification, to the conclusion that acetate inhibited the release of $C^{14}O_2$ (*a*) greatly, (*b*) slightly, or (*c*) not at all, depending on the time when the measurements were made. Unfortunately, not even all kinetic data can be interpreted unequivocally. For instance, from the data described it seems justifiable to conclude that the rate of endogenous respiration of acetate-grown *P. chrysogenum* is not affected by the concurrent oxidation of glucose; yet, as will be discussed more fully elsewhere, it is premature to assert, without auxiliary experiments, that the endogenous respiration is inhibited by the oxidation of acetate.

References

1. BLUMENTHAL, H. J., KOFFLER, H., and GOLDSCHMIDT, E. P. *Bact. Proc.*, 139 (1951).
2. BURRIS, R. H. In W. W. Umbreit, R. H. Burris, and J. F. Stauffer (Eds.), *Manometric Techniques and Tissue Metabolism*, 2nd ed. Minneapolis: Burgess (1949).
3. REINER, J. M., GEST, H., and KAMEN, M. D. *Arch. Biochem.*, **20**, 175 (1949).
4. COCHRANE, V. W., and GIBBS, M. *J. Bact.*, **61**, 305 (1951).
5. WIAME, J. M., and DOUDOROFF, M. *Ibid.*, **62**, 187 (1951).

6. Stout, H. A., and Koffler, H. *Ibid.*, 253.
7. Goldschmidt, E. P., Koffler, H., and Blumenthal, H. *J. Abstr., XIIth Intern. Congr. Pure Applied Chem.*, 57 (1951).
8. Martin, S. M., and Wilson, P. W. *Arch. Biochem. Biophys.*, **32**, 150 (1951).
9. Schweitzer, G. K., and Stein, B. R. *Nucleonics*, **7**, 65 (1950).
10. Umbreit, W. W., Burris, R. H., and Stauffer, J. F., Eds. *Op. cit.*

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Radiochemical Preparation of Heptadecene-8[1]

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During the course of studies concerned with the role of radioactivity in petroleum genesis, a highly purified sample of oleic acid was bombarded with 14 mev deuterons in the MIT cyclotron (*1*). Previous investigations (*2–4*) had shown that decarboxylation is a predominant reaction during the exposure of fatty or naphthenic acids to α-particles or to deuterons. Heptadecene-8 was, therefore, anticipated as a major product from the irradiation of oleic acid.

$$CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH \rightarrow CH_3(CH_2)_7CH{=}CH(CH_2)_6CH_3 + CO_2$$

Following bombardment of 56.8 g of the purified oleic acid (free from stearic acid) for 2 hr with an average beam intensity of 9 μamp, using the gold-plated chamber described by Honig (*5*), the recovered viscous liquid was saponified by refluxing for 3 hr with alcoholic sodium hydroxide. The solution was then extracted with ether, and the extract was dried over sodium sulfate and evaporated on a steam bath. The yellow, viscous, nonsaponifiable residue amounted to 10% of the oleic acid originally bombarded. Part of this material (950 mg) was dissolved in 100 ml pentane and passed through a 12×800 mm column packed with a 5:1 Florosil-Celite 545 mixture. The effluent and wash pentane fluoresced deep blue under ultraviolet light. After the pentane was evaporated, a light, almost colorless liquid remained which had a melting point of 15°–20° C. On preliminary micro vacuum distillation using a simple U-type still, a solid residue remained. This material, which was not further investigated, amounted to about 0.5%, based on the original oleic acid, and had a melting point of 50°–60° C. Hydrogenation of a portion of the distillate (3% of the original oleic acid bombarded) indicated the liquid to contain 92% of mono-olefin based on the molecular weight (238) of the anticipated heptadecene.

Fractionation of a second portion of the chromatographed material (300 mg) in a micro still described by Craig (*6*) led to the recovery of a number of fractions, of which 5 had approximately the same boiling points and refractive indices. These 5 fractions were combined, and the physical properties of the resulting liquid are shown in Table 1.

An effort was made to establish the position of the double bond chemically. Approximately 75 mg of the material was ozonized in pentane at −30° C, and the resulting ozonides were hydrolized. The acids thus obtained were isolated and converted to the anilides with the intention of obtaining an x-ray powder pattern by which to identify the individual acids present (*7*). Unfortunately, impurities in the anilides caused a depression of the melting point so that the mixture could not be crystallized at room temperature. Attempts to purify the product further were not successful, and insufficient material was available for repetition of the work.

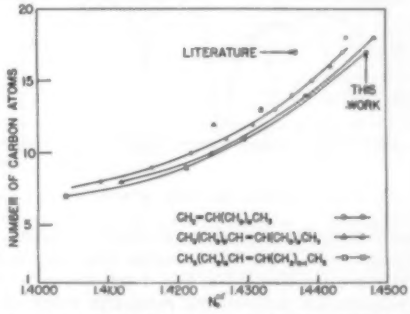


FIG. 1. Refractive indices of the isomeric normal monoolefins.

As indicated in Table 1, the refractive index and melting point of the unsaturated hydrocarbon obtained by radiochemical decarboxylation of oleic acid differ considerably from the values reported in the literature for heptadecene-8.

It has repeatedly been shown (*8–10*) that both the density and refractive index of an olefin increase as the double bond is shifted to the center of the molecule. Although heptadecene-1 has been reported as having n_D^{20} 1.4438 (*11*), the value for heptadecene-8 has been given as n_D^{20} 1.437 (*10*). The value for heptadecene-8

TABLE 1

PHYSICAL PROPERTIES OF HEPTADECENE-8

	Observed	Literature
D_4^{20}	0.802	0.795/25° (*13*)
N_D^{20}	1.472	1.437 (*11*)
Boiling point (corr), °C	297–298	173/16 mm (*13*)
Melting point (corr), °C	−12.5 to −11.5	−50 (*13*)
Double bonds/molecule (catalytic hydrogenation)	1.02 ± 0.05	1*
Carbon (%)	85.9	85.7*
Hydrogen (%)	14.1	14.3*

* Calculated.

[1] This paper is a contribution from American Petroleum Institute Research Project 43C, located at the Massachusetts Institute of Technology; W. L. Whitehead, director; Clark Goodman, physical director.

[2] Present address: The Polaroid Corp., Cambridge, Mass.

[3] Present address: U. S. Geological Survey, Washington 25, D. C.

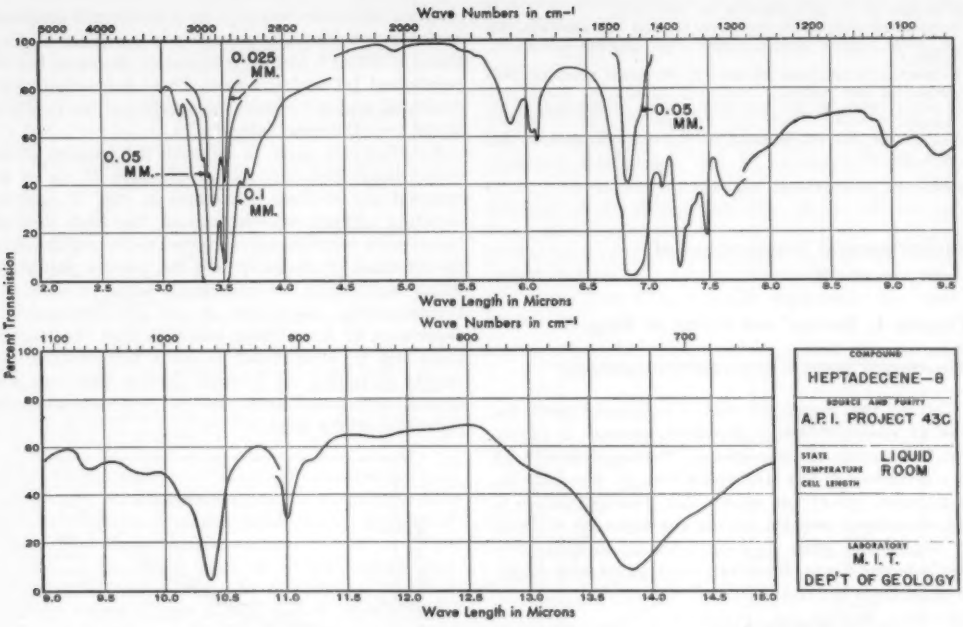


FIG. 2. Infrared spectrum of heptadecene-8 prepared by the radiochemical decarboxylation of oleic acid.

appears to be in error since, as indicated above, the compound with the internal double bond should have the higher refractive index. Fig. 1 was drawn to show the relationship between the refractive index of the hydrocarbon obtained in this work and of heptadecene-8 reported in the literature. One curve represents the indices of olefins having a terminal double bond; the second, the symmetrical compounds having the double bond in the center; and the third, the unsymmetrical compounds with the double bond occupying the linkage next to the center carbon atom. Discrepancies in the value for dodecene-6, tridecene-6, and heptadecene-8 are obvious from the figure. As indicated, the value for the hydrocarbon obtained in this work falls on the extrapolated curve of the unsymmetrical compounds.

Certain methods for the preparation of olefins are known to result in a mixture of isomers as a result of rearrangement of the double bond. Noorduyn (*12*) in his study of the constitution of olefins prepared by heating the barium salts of fatty acids with sodium ethoxide or sodium methoxide showed, by ozonolysis of the product, that the heptadecene-8 thus prepared from barium oleate was actually a mixture of isomers. No physical properties were given for this preparation. It is likely that the heptadecene-8 (Table 1) reported by Messer (*13*) is also a mixture, since it was prepared by distilling sodium oleate with sodium ethoxide.

Fig. 2 shows the infrared spectrum of the heptadecene obtained in this work. According to Rasmussen, Brattain, and Zucco (*14*), the strong band at 10.3 μ is characteristic of the *trans* form of RHC=CHR compounds, whereas the *cis* form has a weaker band of more variable position in the 10–11 μ region (*15*).[4] The *cis* form also has a strong band in the 14–16 μ region. From the absence of the latter band and from the shape and intensity of the 10.3 μ band, it appears that the heptadecene prepared in this work is at least predominantly of the *trans* form.

It appears from this work that heptadecene-8 of considerably higher purity than that previously reported has been prepared by the radiochemical decarboxylation of oleic acid. This study indicates the possibility of using high energy sources of radiation in the synthesis of organic compounds or their intermediates. In this case, the use of radiation has led to a practical method for the preparation of a high molecular weight olefin with an internal double bond. Compounds of this type have in the past been difficult to obtain in a satisfactory state of purity.

References

1. BURTON, V. L. *J. Am. Chem. Soc.*, **71**, 4117 (1949).
2. SHEPPARD, C. W., and WHITEHEAD, W. L. *Bull. Am. Assoc. Petroleum Geol.*, **30**, 32 (1946).
3. SHEPPARD, C. W., and BURTON, V. L. *J. Am. Chem. Soc.*, **68**, 1636 (1946).
4. BREGER, I. A., and BURTON, V. L. *Ibid.*, 1639.
5. HONIG, R. E. *Rev. Sci. Instruments*, **18**, 389 (1947).
6. CRAIG, L. C. *Ind. Eng. Chem. Anal. Ed.*, **9**, 441 (1937).

[4] We are grateful to Mark Fred, of the Armour Research Foundation, for calling this reference to our attention and for the present interpretation.

7. MATTHEWS, F. W., and MICHELL, J. H. *Ibid.*, **18**, 662 (1946).
8. WHITMORE, F. C. *Organic Chemistry*. New York: Van Nostrand, 29 (1937).
9. SHRINER, R. L., and FUSON, R. C. *Identification of Organic Compounds*. New York: Wiley, 101 (1940).
10. DUNSTON, A. E. *Science of Petroleum*, Vol. 2. Oxford: University Press, 1350 (1938).
11. DOSS, M. P. *Physical Constants of the Principal Hydrocarbons*, 4th ed. New York: Texas Co. (1943).
12. NOORDUYN, A. C. *Rec. trav. chim.*, **38**, 317 (1919).
13. MESSER, W. E. *Chem. News*, **138**, 292 (1929).
14. RASMUSSEN, R. S., BRATTAIN, R. R., and LUCCO, P. S. J. *Chem. Phys.*, **15**, 135 (1947).
15. FRED, M., and PUTSCHER, R. *Anal. Chemi.*, **21**, 900 (1949).

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Frequency of Dicentric Bridges in Meiosis in the Grasshopper *Gesonia punctifrons*, Produced by Different Dosages of X-Rays[1]

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Experimental work on the effects of x-rays on the chromosomes of both animals and plants has been carried out mainly on the mitotic chromosomes. Similar studies on meiosis (*1–4*) have sometimes yielded contradictory results. In animals, especially, the studies on irradiated meiotic chromosomes (*5–11*) are not very numerous, and it seems desirable to have more quantitative data on the induced aberrations, obtained by direct cytological examinations conducted on the divisions immediately following treatment. We have, therefore, made a large-scale attempt to secure such data, as they seem to us to be essential not only for the understanding of the nature and causes of structural changes in the karyotype during evolution, but also for their special significance in relation to the effects of ionizing radiation. In the present paper we shall restrict ourselves to the presentation of the data of only one class of abnormality among several others found—namely, the frequency of dicentric bridges with fragments. These were detected at the first anaphase of meiosis by irradiating the testes of the grasshopper *Gesonia punctifrons*, a species with 23 acrocentric chromosomes in the males (Table 1).

Six experiments were carried out, with irradiations on the following dates: I, 5/12/48; II, 6/21/49; III, 4/3/50; IV, 5/9/50; V, 8/20/50; VI, 10/9/50. The grasshoppers to be treated with a particular dosage were put in separate muslin bags 4 × 5 cm in size. Two or three such bags, depending on the number of doses to be given in a particular experiment, were placed one upon another at a distance of 50 cm from the target. They were removed one by one at predetermined intervals. Radiation was carried out in the Radiology Department of the Calcutta Medical College, and the source of the x-rays was a G-E Maximar therapy tube. The voltage used was 200 kv, and the current was kept constant at 10 ma. The radiation was filtered through .5 mm copper and 1 mm aluminium filters. The dosages were varied by altering the time of exposure alone. It was not possible to measure the dosages in r-units in every experiment separately because the usual practice in this hospital is to calibrate the output of the tube at certain intervals of days. The various dosages indicated are therefore approximate, and errors of total dosages received in different experiments may be of the order of 4–5%.

The dosages used and the intervals between irradiation and treatment are shown for Expts I and II in Tables 2 and 3, respectively. In Expt III the only dosage was 80 r, the only interval 26 hr; in IV the doses were 40 r and 80 r, and the intervals 30 and 48 hr; in both V and VI the dosages were 40 r, 80 r, and 120 r, and the interval was always 30 hr.

G. punctifrons has been frequently used in our laboratory as experimental material and for the study of normal meiosis. Dicentric bridges were never observed in unirradiated material. It was therefore decided to have a single lot of grasshoppers to serve as controls, and the data for unirradiated material come from this lot alone.

TABLE 1

FREQUENCY OF DICENTRIC BRIDGES IN DIFFERENT EXPERIMENTS AT 30 HR AFTER IRRADIATION

Expt	40 r		80 r		120 r	
	Chromosomes	Bridges	Chromosomes	Bridges	Chromosomes	Bridges
I*	690	4			2,507	36
II	1,311	5	966	8		
IV	1,679	10	2,392	25		
V	1,794	7	2,093	16	4,278	47
VI	6,279	22	4,554	32	2,622	31
Sum	11,753	48	10,005	81	9,407	114
%		.41		.81		1.21
χ^2		2.50		2.36		1.53
P		.7		.5		.5

* Expt I, 280 r: 368 chromosomes, 17 bridges, 4.6%; Expt I, 320 r: 1,311 chromosomes, 47 bridges, 3.6%.

The frequencies of dicentric bridges accompanied by fragments in the first anaphase of meiosis, obtained in the different experiments when examined at 30 hr after irradiation, are shown in Table 1. It will be clear from the data that the frequencies found in the different experiments, with the same dosage, remain more or less constant, as the total χ^2 values indicate in each case. The corresponding value of P is not significant in any of the dosages, and therefore the slight deviations in the frequencies obtained during several repe-

[1] The authors record their deep sense of indebtedness to H. J. Muller for valuable suggestions incorporated in this paper. Thanks are also extended to S. Mukherji, professor of radiology, Calcutta Medical College, for providing facilities for x-raying in his hospital.

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TABLE 2

FIRST ANAPHASE BRIDGES AT VARIOUS HOURS AFTER IRRADIATION IN EXPT I

Hours after irradiation when fixed	40 r		120 r		280 r		320 r	
	Chromosomes examined	Bridges	Chromosomes examined	Bridges	Chromosomes examined	Bridges	Chromosomes examined	Bridges
6	1,219	1	—	—	—	—	—	—
12	1,173	4	1,380	15	1,380	56	—	—
24	1,219	3	460	3	1,196	42	575	20
30	690	4	2,507	36	368	17	1,311	47
48	1,104	6	1,495	17	1,127	8	851	33
72	552	2	2,162	24	253	15	1,610	38
χ^2 and P	$\chi^2 = 5.30$; $P = .5$		$\chi^2 = 2.70$; $P = .7$		$\chi^2 = 34.78$; $P < 10^{-6}$		$\chi^2 = 5.73$; $P = .2$	

titions of the experiment are negligible. The χ^2 values for 280 r and 320 r could not be calculated, for obvious reasons.

The data presented in Table 2 give the number of bridges obtained in the first experiment when the fixation was done at various hours after irradiation at the different dosages. The data for 6 and 12 hr at the relatively higher dosages could not be scored because the "sticky" bridges and other abnormalities characteristic of the physiological effect of irradiation persist up to 12 hr with 320 r and up to 6 hr with 120 r and 280 r. The χ^2 values for each dosage shown at the bottom of the table were calculated on the assumption that the frequencies do not vary at different hours for a particular dose. Their low values and the correspondingly high values of P at all dosages except 280 r indicate that the frequency remains essentially the same within the time limits of the experiment. The very high value of χ^2 (34.78) with 280 r is entirely due to an abnormally low frequency of bridges obtained at 48 hr. The recalculated value of χ^2, if we omit the data for 48 hr, is 3.48, and for 3 degrees of freedom the value of P is 0.50 and therefore shows no significant differences.

Expt II was carried out primarily to determine whether the frequency of bridges remains the same when the hours of fixation are extended even farther. The data obtained are shown in Table 3. The value of χ^2 with 11 degrees of freedom at 40 r and 80 r is very low and leads to the conclusion that the frequency of bridges does not vary significantly from the mean of all the different hours at a particular dosage.

We have shown that the frequency of bridges does not vary significantly from one experiment to another when the examination is made at 30 hr after treatment (Table 1). We are therefore justified in adding up the results of different experiments for the various dosages. The data presented in Table 1 indicate that the percentage of bridges is directly proportional to the dosage of radiation. This conclusion can be further strengthened if we add up the data for all hours at each dose. This can be done because we know that the frequency of bridges remains more or less constant at different hours after irradiation (Tables 2 and 3). The pooled results of all experiments at all hours, for each dose, are shown in Table 4. The percentages of bridges are, in general, clearly proportional to the dose. A slightly higher frequency is observed at 280 r in Tables 1 and 4. This deviation from direct proportionality is not significant, however, because doses of 280 r and 320 r do not differ much relatively, and the standard errors of the percentages obtained at each of these doses are comparatively high, owing to their being based on the examination of relatively few chromosomes.

Our results for anaphase bridges can be taken as

TABLE 3

FIRST ANAPHASE BRIDGES AT VARIOUS HOURS AFTER IRRADIATION IN EXPERIMENT II

40 r*			80 r†		
Hours	Chromosomes	Bridges	Hours	Chromosomes	Bridges
10	736	4	18	529	4
18	874	6	30	966	8
26	1,380	3	34	644	6
30	1,311	5	38	782	2
34	1,173	9	42	874	7
42	2,346	13	54	828	7
50	621	1	58	253	2
54	1,012	2	66	644	4
58	2,139	8	92	1,058	7
74	1,081	5	108	460	4
92	1,150	5	140	2,783	19
108	1,173	6	148	736	8

* $\chi^2 = 8.29$; $P = .70$.
† $\chi^2 = 4.74$; $P = .95$.

TABLE 4

DOSAGE-FREQUENCY RELATIONSHIP OF THE FIRST ANAPHASE BRIDGES
(Total for all hours)

Dose (in r)	Total chromosomes examined	Total bridges	Percentage
40	30,705	124	0.40
80	21,267	166	0.78
120	14,304	173	1.21
280	4,324	138	3.19
320	4,347	138	3.17
0 (Controls)	4,289	Nil	Nil

agreeing closely enough with a relationship of direct linear proportionality of number of effects to dosage used. If these aberrations result from inversions or other changes involving two independent breaks, then we should as a first approximation expect the number of cases to vary as the square of the dose. The relationship would be somewhere between the first power and the square, however, if the radiation had to be extended over a time very much longer than it usually takes for a broken end derived from one break to find and unite with a broken end derived from another break. The time of treatment at different x-ray dosages in our experiment varied only between 1 and 14 min, and therefore, if the changes were due to two independent breaks, the frequencies found should in fact vary nearly as the square of the dose. In view of the statistics of our results we have to conclude that most of the bridges are not formed by independent breaks, but by one or more breaks caused by a single ionization or activation, or occurring in the course of a single ionizing track.

The hypothesis which appears to us most probable is that the breaks of the two chromatids which, on uniting with one another, form the dicentric chromosome of the first anaphase bridge, are both derived from one break, which occurred in a chromosome before its division into chromatids. This is the hypothesis which was proposed by Muller (*12*) to explain losses of single chromosomes that had been irradiated in the spermatozoon stage. It also corresponds in principle with the spontaneous breakage-fusion-bridge cycle found by McClintock (*13*) in maize. The sequence of events, as we conceive it to occur in our material, is represented in Fig. 1, *a* to *e*. It will be seen that this series of steps is similar in its later stages to that proposed by A. R. Whiting (*9, 10*) for the chromosome bridges found by her in the second meiotic anaphases of *Habrobracon* oocytes irradiated during the latter part of the first meiotic metaphase. Since, however, the chromatids were already in existence at the time of irradiation, it was clear that in her material each second anaphase bridge represented the effect of two breaks, one in each of two neighboring chromatids. It was inferred from the linear relation to dose that both breaks were caused by the same "hit."

The constancy of the frequency of bridges recorded at different hours after irradiation, up to a period of 148 hr, is a curious phenomenon. In grasshoppers, a long resting period intervenes between the last spermatogonial division and the onset of meiosis. The large majority of bridges which we detect between 12 and 148 hr at the lower dosages (the results at 6 hr being too few to be significant), and between 10 and 72 hr at relatively higher ones, probably originate in chromosome breaks induced by radiation during this resting period.

In the case of a small fraction of bridges in our material, especially those observed at less than 12 hr after treatment at higher doses, it may be that, as Whiting believes to happen in her material, they originate during the early prophase of meiosis, in pachytene or as late as early diplotene, by a single "hit" breaking both the sister chromatids; these cases, like the others, would have to undergo sister reunion later, so as to give rise to a bridge and fragment at anaphase I. According to Darlington and Koller (*14*), the regions between the chromomeres in the prophase of meiosis are relatively undercharged with nucleic acid; they believe that chromosome threads in this condition have breakages more readily induced in them, in these regions, by radiation.

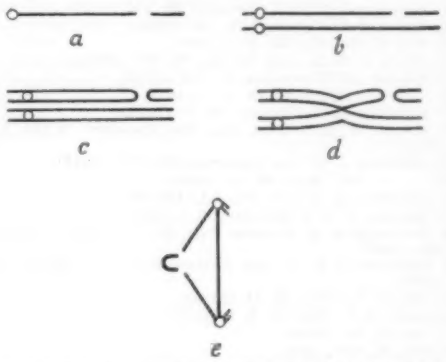


FIG. 1. *a*, A break in an unsplit chromosome; *b*, the broken chromosome pairing with its unbroken homologue; *c*, pachytene, after the reproduction of chromosomes, the centric and acentric chromatids having undergone sister reunion; *d*, a chiasma being formed between the centromere and the break; *e*, first anaphase producing a dicentric bridge and a fragment.

We do not think it likely, however, that the chromosomes have already divided into chromatids in the cells which were treated in the less mature stages dealt with in our material. If they have not, then for most of the breaks—those occurring according to the scheme presented in Fig. 1—bridge formation could take place only after the reproduction of the chromosomes at pachytene, by sister union of daughter chromatids derived from broken chromosomes. In that case, in order to explain, under our scheme of bridge formation, the constancy of its frequency for treatments given at widely different times before the first meiotic division, we must infer further that the breaks produced by x-rays in the resting spermatocytes are preserved for a long period—in extreme cases for nearly 148 hr—without undergoing restitution.

This long delay in union of broken ends was first found to hold for the chromosomes in the mature spermatozoa of *Drosophila*, in experiments participated in by Muller and the present senior author in collaboration (*12*). On the other hand, work of numerous authors has been regarded as showing that in most resting (interphase) stages which precede mitotic divisions, the union of broken ends can take place immediately after breakage, most of it being completed, according to Sax (*15*), within less than an hour thereafter. If this is true the conditions for joining of the broken ends during the premeiotic interphase in our material would be different from that generally ob-

served for mitotic interphases. Lane (*16*), however, in work which came to our attention after our interpretation of our own results had been arrived at, has recently concluded, on the basis of evidence obtained by him, that in *Tradescantia* microspores the union of broken ends is, contrary to the previously accepted interpretation for such material, long delayed. His conclusion is at present under dispute (*17, 18*).

References

1. Goodspeed, T. M. *J. Heredity*, **20**, 243 (1929).
2. Riley, H. P. *Cytologia*, **7**, 131 (1936).
3. Sax, K. *Genetics*, **23**, 494 (1938).
4. Stone, L. H. A. *Ann. Botany*, **47**, 815 (1933).
5. Bishop, D. W. *Genetics*, **27**, 132 (1942).
6. ———. *J. Morphol.*, **71**, 391 (1942).
7. Bozeman, M. L. *Genetics*, **28**, 71 (1943).
8. White, M. J. D. *Proc. Roy. Soc. (London)*, B **124**, 183 (1938).
9. Whiting, A. R. *Am. Naturalist*, **79**, 193 (1945).
10. ———. *Biol. Bull.*, **89**, 61 (1945).
11. Marshak, A. *J. Gen. Physiol.*, **19**, 179 (1935).
12. Muller, H. J. *J. Genetics*, **50**, 1 (1940).
13. McClintock, B. *Research Bull. Mo. Agr. Expt. Sta.*, No. 290 (1938).
14. Darlington, C. D., and Koller, P. C. *Heredity*, **1**, 187 (1947).
15. Sax, K. *Genetics*, **25**, 41 (1940).
16. Lane, G. R. *Heredity*, **5**, 1 (1951).
17. *Ibid.*, **6**, 131 (1952).
18. Sax, K. *Ibid.*, 127.

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Effect of a Cationic Detergent on the Digestion of Raw Cornstarch *in Vitro*[1]

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Recent reports have indicated that certain detergents increase the growth rate of chickens (*1*), rats (*2*), and pigs (*3*). The mechanism of such growth stimulation is not understood, but it has been suggested that it is related to surface-active properties (*4*).

During a study of the digestion of raw cereal starches by α-amylases from various sources, it was noted that the presence of "Roccal,"[2] a mixture of high molecular weight alkyl-dimethyl-benzyl-ammonium chlorides, was effective in increasing the rate of action of the α-amylases from fungal, bacterial, and animal sources. This detergent was effective in increasing the activity of the amylases on the raw starches but not on cooked starches.

The exceedingly slow rate of digestion of raw starches is well known. It is possible that some of the energy value of a feed is not made available to the animal because of incomplete digestion during the relatively short period in the intestinal tract—an increase in the rate or extent of digestion should increase the efficiency of gain.

The data presented in Table 1 indicate the effectiveness of Roccal in increasing the rate of action of pancreatic amylase on raw starch. These data show that the increased rate of action was evident over a pH range from 5.4 to 7.8, but was most effective near the pH of maximum activity. Table 2 compares the effect of the detergent, an organic electrolyte, with two inorganic electrolytes that are known to stimulate the action of pancreatic amylase on cooked starch.

TABLE 1

Effect of 0.1% Roccal on the Digestion of 500 mg Raw Cornstarch by 4 mg Pancreatin*

pH	Raw starch digested		
	Without detergent (%)	With detergent (%)	Increase of activity (%)
5.4	25.7	27.6	7
6.2	37.2	54.1	45
7.0	37.1	58.3	57
7.8	31.8	51.2	57

* Twenty-hr digestions carried out at 30° C on 20 ml 2.5% raw cornstarch suspension, buffered with phosphate and constantly agitated.

TABLE 2

Electrolyte Stimulation of the Digestion of 500 mg Raw Cornstarch by 1.5 mg Pancreatin, pH 6.5*

Digestion condition	Raw starch digested	
	Amount (%)	Increase of activity (%)
Without detergent		
Control	28	—
0.05% NaCl	37	32
0.10% NaCl	38	35
0.10% $CaCl_2$	37	32
With 0.1% detergent		
Control	43	54
0.05% NaCl	45	61
0.10% NaCl	46	64
0.10% $CaCl_2$	56	100

* Twenty-hr digestions carried out at 30° C on 20 ml 2.5% raw cornstarch suspension, buffered with phosphate and constantly agitated.

The demonstrated stimulation of pancreatic α-amylase by calcium or sodium chlorides, and the stimulation of raw starch digestion by Roccal, suggest that these two effects may be the same or similar in mechanism. To obtain information concerning the action of these two types of enzyme stimulant a series of determinations was made in which the stimulants were studied individually and in combination on raw starch digestion. Digestions were carried out with 0.10% Roccal alone, with .05% and .10% sodium chloride, and 0.10% calcium chloride, both individually and in combination with the 0.10% Roccal, each digest being

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[2] Roccal is the brand name of a product sold by Sterwin Chemicals, Inc., New York 18.

adjusted to pH 6.5 with $M/15$ phosphate. A control digestion at the same pH was carried out with no activator present.

The results of this study, presented in Table 2, show the extent of stimulation realized by each of the treatments. With the pancreatic enzyme the inorganic salts increased the activity, but the increase seemed to be independent of concentration or kind of salt. A considerably greater increase in activity was observed when Roccal was used—about double the amount of activation afforded by the inorganic salts. Even with Roccal present, however, additional stimulation resulted from the addition of the sodium chloride. When calcium chloride and Roccal were both present, the activity was increased to 200% of the unstimulated digestion.

These data suggest a possible explanation of the growth stimulation obtained with chickens, rats, or pigs when they are fed detergents. It seems probable that the presence of the detergent permits a more ready penetration of the starch granule by the enzyme. This would make available a greater portion of the substrate for enzyme attack during the limited time in the digestive tract, and accordingly would increase the rate of starch digestion by the enzyme.

References

1. Ely, C. M. *Science*, **114**, 523 (1951).
2. Harris, R. S. *Arch Biochem. Biophys.*, **34**, 249 (1951).
3. Luecke, R. W., Hoefer, J. A., and Thorp, F., Jr. *Quart. Bull. Mich. Agr. Expt. Sta.*, **34**, (3), 331 (1952).
4. Stern, J. R., Gutierrez, J. C., and McGinnis, J. Rept. Am. Chem. Soc. Mtg., Buffalo (1952).

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Putrescine as a Growth Requirement for *Neisseria*[1]

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Recently Herbst and Snell (*1*) have shown that the bacterium *Hemophilus parainfluenzae* requires the diamine putrescine for growth in a chemically defined medium. This was the first instance in which one of the putrefactive diaminic compounds was shown to be essential for bacterial growth. The compounds spermine, spermidine, and agmatine could replace putrescine, and it is conceivable that their activity is via putrescine, which would be formed as a result of hydrolytic cleavage.

Previous work in our laboratory, by Nemes *et al.* (*2*), on the nutritional requirements of nonpathogenic *Neisseria* has shown that many of these organisms require biotin in a vitamin-free casein hydrolysate medium. Attempts to cultivate *N. perflava* in media where the casein hydrolysate was replaced with complex amino acid mixtures were unsuccessful. Numerous vitamins and growth-factor compounds were then tested, and during the course of this work it was found that putrescine, in addition to biotin, was essential for growth of some strains of *N. perflava*.

[1] This investigation was supported, in part, by a research grant from the Division of Research Grants and Fellowships of the National Institutes of Health, USPHS.

TABLE 1

Composition of Basal Medium Supporting Growth of *N. perflava*

Amino acids	Amount/liter
DL-aspartic acid	1.0 (g)
L-glutamic acid	1.0
DL-alanine	1.0
L-arginine	0.20
DL-methionine	0.20
DL-threonine	0.20
DL-serine	0.20
DL-tryptophane	0.20
DL-valine	0.20
DL-phenylalanine	0.20
DL-isoleucine	0.20
L-lysine	0.20
L-leucine	0.10
L-proline	0.10
L-histidine	0.10
L-cystine	0.10
L-tyrosine	0.10
Glycine	0.10
Biotin	1.0 μg
Putrescine	1.0 mg
Salt solution A	5.0 ml
K_2HPO_4 25 (g)	
KH_2PO_4 25	
H_2O 250 ml	
Salt solution B	5.0 ml
NaCl 0.5 (g)	
$FeSO_4 \cdot 7H_2O$ 0.5	
$MnSO_4 \cdot 4H_2O$ 0.5	
$MgSO_4 \cdot 7H_2O$ 10.0	
H_2O 250 ml	

The growth response of *N. perflava* (876) to graded amounts of putrescine is illustrated in Fig. 1. For this determination the medium was dispensed in 10 ml

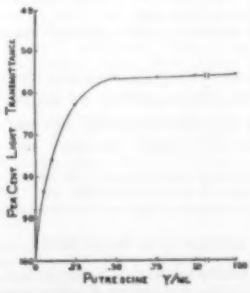


Fig. 1. Growth response of *N. perflava* to graded amounts of putrescine in a chemically defined medium.

amounts into 125-ml Erlenmeyer flasks and sterilized by autoclaving at 10 psi for 10 min. The inoculum consisted of approximately 0.01 ml of a washed cell suspension, and the incubation period was 48 hr at 35° C. Growth was measured turbidimetrically with a Klett-Summerson photoelectric colorimeter, using the blue filter. No growth occurred in the absence of putrescine, and maximum growth response was obtained at a concentration of approximately 0.5 μg/ml. Growth response of the organism was almost linear between 0.05 and 0.25 μg putrescine/ml. The presence of putrescine did not alter the biotin requirement for this organism. Three additional strains of *N. perflava* have been investigated, and all demonstrate a requirement for putrescine similar to that exhibited by culture #876.

Other diaminic compounds[2] which we have tested for growth response with *N. perflava* (876) indicate that spermidine, agmatine, and cadavarine may be substituted for putrescine. Of these compounds, cadavarine was the least active, and it is possible that its low activity might be due to contamination with putrescine.

Experiments are in progress at this time to determine the extent to which the amino acid content of the medium, as shown in Table 1, can be reduced without materially affecting growth, and to determine what effect these alterations may have on the vitamin requirements of this organism.

References

1. Herbst, E. J., and Snell, E. E. *J. Bact.*, **58**, 379 (1949).
2. Nemes, J. L., Pelczar, M. J., and Doetsch, R. N. *J. Infectious Diseases*, **88**, 156 (1951).

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Deficiency of Ceruloplasmin in Patients with Hepatolenticular Degeneration (Wilson's Disease)[1]

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Wilson's disease (hepatolenticular degeneration) is associated with abnormalities in copper metabolism (*1*). The liver and the lenticular nucleus of the brain contain abnormally large amounts of copper (*2*), urinary excretion of copper is excessive (*1, 3*), the pigmented Kayser-Fleischer corneal ring, which is characteristic of the disease, presumably contains copper (*1*), and the level of serum copper has been reported to be abnormal (*4, 5*). Since most, if not all, of the copper normally present in serum is bound to ceruloplasmin (*6*), an investigation of this protein in Wilson's disease was undertaken. This paper reports the first results of the study, which show that there is a deficiency of ceruloplasmin in patients with this disease.

Ceruloplasmin is a blue α-globulin, with a molecular weight of 151,000, containing 0.34% copper, or 8 atoms copper/molecule (*7*). Normal plasma contains about 30 mg of the protein/100 ml so that ceruloplasmin constitutes roughly 0.5% of the plasma proteins. The copper appears to be an integral part of the molecule and is presumably responsible for its blue color, the absorption peak of which is at 6100 A.

Spectrophotometric. This method is based on the observation that the blue color of ceruloplasmin disappears on the addition of reducing reagents (*6*), such as ascorbic acid. Blood from fasting subjects was drawn, with precautions to avoid hemolysis. After centrifuging the blood twice and clarifying the plasma by Seitz filtration, light absorption was measured in a Beckman spectrophotometer from 5400 to 6600 A. A cell with a 5.0 cm path length was required. When successive measurements of the spectral curve showed no change with time, a solution of buffered sodium ascorbate was added in sufficient amount to make the plasma concentration 0.27%. Spectra were measured hourly for at least 5 hr at room temperature, by which time (although not much sooner), the maximum decrease in optical density at 6100 A had occurred. The concentration of ceruloplasmin was estimated by dividing this decrease in optical density, corrected for dilution, by the extinction coefficient $\varepsilon^{5\text{ cm}}_{1\%,\ 6100\ A} = 3.4$.

Immunochemical. Rabbits were immunized with either crystallized or purified ceruloplasmin (prepared and kindly supplied by D. R. Kominz and J. L. Oncley, of the University Laboratory of Physical Chemistry). The antisera obtained, even when crystallized ceruloplasmin was the antigen, gave precipitin tests with other purified plasma proteins, as well as with ceruloplasmin. The antiserum could be rendered specific for ceruloplasmin by repeated absorption with the serum of a patient with Wilson's disease which was particularly low in ceruloplasmin content. The method for the quantitative determination of ceruloplasmin in serum was similar to methods previously published (*8*). Copper determinations were made according to the method of Cartwright, Jones, and Wintrobe (*9*).

The results are shown in Table 1. It is apparent that in each individual the immunochemical method yields consistently higher values for ceruloplasmin than the spectrophotometric method. This is true

[1] This study was supported in part by a grant from the National Institutes of Health, USPHS.

[2] Postdoctoral research fellow of the National Institutes of Health, USPHS.

[3] We are very grateful to D. Denny-Brown, who kindly gave us access to all his patients with Wilson's disease, to J. A. V. Davies, who kindly allowed us to study his patient, D. B., and to L. K. Diamond for generous cooperation in the study of his patients E. M. and M. M. E. L. Rolls and J. A. Murphy provided expert and invaluable technical assistance.

TABLE 1

CERULOPLASMIN LEVELS IN PLASMA AND SERUM OF NORMAL SUBJECTS AND PATIENTS WITH WILSON'S DISEASE

	Spectrophotometric method (mg ceruloplasmin/100 ml plasma)		Immunochemical method (mg ceruloplasmin/100 ml serum)	
Normal subjects	H. M.	16.5		
	H. S.	18.1	H. S.	33.5
	" "	15.4		
	" "	14.2		
	E. B.	15.4	E. B.	25.8
	L. A.	19.0	L. A.	37.6
	N. N.	13.2	N. N.	30.1
	W. Bo.	10.7	W. Bo.	23.6
	W. Be.	12.1	W. Be.	38.7
	Av	15.0	Av	31.6
Patients with Wilson's disease	M. M.	< 2.0	M. M.	4.0
	" "	< 2.0		
	E. M.	< 2.0	E. M.	12.8
	D. B.	< 2.0	D. B.	11.8
	" "	< 2.0		
	" "	2.0		
			E. R.	7.5
			R. K.	6.4
			D. P.	4.3
			M. G.	18.3
			J. G.	9.7
	Av	< 2.0	Av.	9.4

both for normal subjects and for patients with Wilson's disease. It is probable that the immunochemical results are a more reliable index of the plasma ceruloplasmin than the spectrophotometric values. In two instances, copper analyses of the specific precipitate were used to calculate the ceruloplasmin content of the serum. In one normal subject, the value obtained, 39.4 mg %, compares with 33.5 mg % by the immunochemical method and 18.1 mg % by the spectrophotometric method. In the other, a patient with Wilson's disease, copper analysis of the specific precipitate gave a value of 4.6 mg % ceruloplasmin. The immunochemical method gave a value of 4.0 mg %, and the spectrophotometric method gave a value of less than 2 mg %.

The reasons for the inaccuracy of the spectrophotometric method are not clear. The mechanism of the reduction of ceruloplasmin by ascorbic acid in plasma is probably complex, as shown by the fact that the time required to reach equilibrium is so long and that optical densities may rise at a given wavelength before finally falling. The low values of ceruloplasmin obtained by this method may in part reflect the increase in optical density at 6100 A, which hemoglobin solutions give on being treated with ascorbic acid, thus diminishing the net decrease due to reduction of ceruloplasmin. Our plasmas usually contained between 1 and 4 mg hemoglobin/100 ml (*10*).

Nevertheless, we have included the spectrophotometric values for two reasons. First, when the decreases in optical density produced in plasma by ascorbic acid at 6100 A and longer wavelengths are plotted against wavelength, the shape of the curve resembles closely curves obtained with solutions of purified ceruloplasmin. This suggests that ceruloplasmin is responsible for the optical density decrease, although not all the ceruloplasmin appears to react. Second, the differences obtained between normal subjects and patients with Wilson's disease are striking enough to make this method a practical way of studying relative plasma ceruloplasmin levels. The immunochemical method, unfortunately, requires purified ceruloplasmin to produce the antisera, and at present very little ceruloplasmin is available.

Patients with Wilson's disease have much less ceruloplasmin in their serum than normal subjects despite the fact that their copper levels may be either higher or lower than normal (*4, 5*). The ceruloplasmin content of their sera is consistently too low to account for the serum copper present. The excess nonceruloplasmin serum copper is not freely dialyzable since measurement of the cerebrospinal fluid copper of three patients with Wilson's disease showed it to be from one tenth to one third the serum level. This is not surprising in view of the fact that other plasma proteins, including albumin and iron-combining globulin, are capable of binding copper, although not as tightly as ceruloplasmin (*6, 11, 12*).

In order to determine whether hepatic cirrhosis, which is characteristic of Wilson's disease, is associated with deficiency of ceruloplasmin, the serum ceruloplasmin content was measured immunochemically in three patients with Laennec's cirrhosis. The values obtained were 27.9, 47.3, and 51.5 mg/100 ml.

Further studies are in progress to determine the role of ceruloplasmin in normal physiology and Wilson's disease. The familial character (*1*) of the disease suggests that it is another example of a pathologic condition related to a congenital deficiency of a specific plasma protein, such as is seen in hemophilia.

References

1. DENNY-BROWN, D., and PORTER, H. *New Engl. J. Med.*, **245**, 917 (1951).
2. CUMINGS, J. N. *Brain*, **71**, 410 (1948).
3. MANDELBROTE, B. M., *et al. Ibid.*, 212.
4. GLAZEBROOK, A. J. *Edinburgh Med. J.*, **52**, 83 (1945).
5. BEARN, A. G., and KUNKEL, H. G. Abstr. 44th Ann. Meeting Soc. for Clin. Invest., Atlantic City, N. J. (1952).
6. HOLMBERG, C. G., and LAURELL, C.-B. *Acta Chem. Scand.*, **1**, 944 (1947).
7. ———. Abstr. No. 291/8, 1st Intern. Congr. Biochem., Cambridge, Eng. (Aug. 19–25, 1949).
8. GITLIN, D. *J. Immunol.*, **62**, 437 (1949).
9. CARTWRIGHT, G. E., JONES, P. J., and WINTROBE, M. M. *J. Biol. Chem.*, **160**, 593 (1945).
10. CROSBY, W. H., and DAMESHEK, W. *J. Lab. Clin. Med.*, **38**, 829 (1951).
11. KLOTZ, I. M., and CURME, H. G. *J. Am. Chem. Soc.*, **70**, 939 (1948).
12. KLOTZ, I. M., FALLER, I. L., and URQUHART, J. M. *J. Phys. & Colloid Chem.*, **54**, 18 (1950).

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Comments and Communications

Di-Section—a Dorsalgic Errata

THE note "Dissa and Data," by S. Reid Warren, Jr., and the Editors (SCIENCE, 115, 633 [1952]) is a welcome crutch for the stability of our language. I would like to extend the "dissa" to a matter of pronunciation.

By common usage "dissection" has been converted to "di-section," against the rules, the sense, and the dictionaries. After years of trying to sweep back the tide, I was encouraged by A. Weir Bell's "A Dice-Sertation on Dice-Section" (*Turtox News*, 27, 154 [1949]), in which he finishes with the battle cry *"Dis* is de only way to say dis woid!" This has been on my bulletin board ever since, and some students have been sent to read it as many as three times.

But Dr. Bell's reinforcement is not enough. One of our students who had got the point comes back to report that not only is "di-section" tolerated among the students in medical school anatomy, it is used by some of the staff!

So I join Dr. Warren in doubt as to where we stand. I am reminded of a youthful confusion: In the South African Railways the guard's van (conductor's sanctum) was homologous to our caboose. In the present linguistic processing are we in the vanguard or the guard's van? If we are really at the tail end of the trend, let us call a halt and rally for an advance to the rear!

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I SHOULD like to answer S. Reid Warren, Jr. He asks: "Shall I continue my former practices of instruction, or shall I stop being a bigot and forget?" Shall I continue to insist that "the word 'data' should be related to a plural verb form, as 'the data are,' and that the word 'disinterested' means impartial or unbiased?" In spite of the offer of the Editors of SCIENCE to help, Dr. Warren is fighting a losing battle.

In a letter to a literary review periodical, I tried to stop the use of "intrigue" as a verb, meaning to fascinate, as in the expression "it intrigues me." Whether used as an intransitive verb meaning to indulge in underhand plotting, or as a noun meaning a scheme for entangling others, intrigue connotes rascality and never pleasure or fascination, unless possibly in a clandestine rendezvous. In return for my efforts, all I received in reply was an irate letter from a Florida woman, who cited five definitions from a new American dictionary (price, $5.00); the first three defined intrigue as she used it, and the last two defined it correctly. I replied, pointing out that, whereas she had a new American dictionary on her side, I had the Oxford dictionary, which gave seven definitions of intrigue, six in the correct sense and a seventh in the modern popular sense, labeled "colloquial" or "a journalistic gallicism." In a second letter, which the editor did not publish, I admitted that the lady from Florida would win in the end, not only because she had a new $5.00 American dictionary on her side, but also the radio, newspapers, debutantes, and the editor of the literary magazine, whereas I had only the King's English. For these same reasons Dr. Warren cannot win.

Everyone seems to forget that if we say "data are" we must also say "datum is," and Americans do not know the word "datum." The hopelessness of the situation is seen in the use of "visa" in the singular. In Germany one asks for a "visum," but it is "a visa" in America, and if you want two, you double the plural and say "visas." To correct this habit would be impossible.

Lord Russell put the whole matter in a nutshell when, in a controversy with Shaw, he was asked how he pronounced "dynasty." He replied: "I say dŷn-asty, but so many persons nowadays say dī-nasty that I am almost ashamed to pronounce it correctly."

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MY OBSERVATION for more than a score of years has been that the first requirement of clear writing is clear thinking. Let me suggest that Dr. Warren continue his present efforts and also add to those efforts a stronger, definite attempt to obtain clearer thinking among his students.

No thinker will challenge the statement that a person who is satisfied, for example, with the program note "between each number" has had little if anything more than a parrot education. Such an education is not mandatory in good schools.

I am still annoyed over the fact that whatever I know about correct English has come mostly from my own efforts and emphatically not from my last two formal instructors in the subject. Their superficialities wasted six years of my "schooling" in languages.

Of course, a lazy or indifferent student is hardly likely to appreciate a Dr. Warren—more's the pity.

HENRY HENDRICKS KETCHAM

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I, TOO, object to the acceptance of English custom modified through inadequate language training. May I add "strata is" and "errata is" to my stimuli to the use of a red pencil?

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WHILE [Although] I share Dr. Warren's bigotry and yours regarding the common misuses of "data," "disinterested," "presently," and "due to"—you might have added "comprise" used in place of "constitute"—

I am sorry that you taboo the adversative "while." "While" can sometimes be used correctly in places where "although" or "whereas" could be substituted without material change of meaning. The "while" at the beginning of this note could be replaced by "although," but that casual "while" implies a shade more clearly that my agreement is a matter of course.

"Whereas" is rarely used at the beginning of a sentence except in leading up to a "Therefore be it resolved;" it is more frequently placed later, where the alternative is not "although" but "while." If you write "The west slope of the range is gentle, while the east slope is steep," you point out a contrast without marked emphasis; and it is sometimes appropriate to do just that. If you replace "while" by "whereas," you emphasize the contrast, which is appropriate if you mean to be didactic or argumentative—especially when, in a controversy, you want to imply that your dull-witted opponent is blind to the significance of the contrast. But the milder adversative "while"—which is a different word from temporal "while," though spelled in the same way—is supported by good usage, and I for one want to feel free to use it in places where it cannot be confused with temporal "while." Confusion can sometimes be prevented by the use of a comma; adversative "while" should usually be preceded by a comma, while [whereas] temporal "while" usually should not.

The commonest misuse of "while" (which you fail to point out) is putting it in place of "and."

Editors and writers of handbooks on composition are too ready to throw a word out of the language because it is often misused. As a result, many young writers are afraid ever to use "since" as a causal conjunction, or to write the word "case" unless they mean a case of liquor. The best cure for misuse of these words is to practice using them correctly. To abolish them is to be like the fond father in one of Sam Weller's anecdotes, who cut off his little boy's head to "to cure him o' sqvintin'."

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EDITORIAL NOTE: *The editorial changes that would normally be made in Dr. Calkins' communication are indicated, because "and" is available for coordinate clauses; "although," for subordinate clauses implying or making a qualification or reservation; and "whereas," for clauses pointing a contrast. Surely one word, "while," can be reserved for temporal clauses involving events occurring at the same time. The Editors are, of course, grieved that they cannot lay editorial pencil on misusages within quotations. Although they grant that the west slope was gentle and the east slope steep at one and the same time, they are certain that the author of the statement was not concerned with contemporaneity but with contrast.*

S. REID WARREN'S note on the "Dissa and Data" and your comment thereon invite further remark. One of the thought-control techniques of George Orwell's *1984* is to do away with various words so that they shall not be available to embody subversive meanings. In the process referred to by you, distinctions of meaning disappear, but the words remain and take on meanings duplicating those previously carried by other words. In addition to the instances already cited are "bullet" = "cartridge," "enormity" = "magnitude," "prone" = "supine," "will" = "shall." From the standpoint of scientific usage, "concept" is perhaps the chief loss; the word has become gobbledygook for "idea" or "notion."

Semantic change is, of course, always with us, but the speeded communication processes of our day accelerate it. The particular sort of change here considered looks like a function of cultural leveling associated with economic levelings of recent years. When the cultural milieu is no longer sensitive to a nuance of meaning such as is carried by "disinterested," it is natural for this meaning to disappear (the word's persistence in favor of "uninterested" may be due in part to phonetic qualities). As the weight of authority in usage passes to a more "common" source, the perceptivity connoted by these more specialized meanings no longer operates, and the words become mere synonyms for existing expressions, as above.

The history of the English language endowed it with an exceptionally large vocabulary, well suited to representing finer shades of meaning—some of them finer, apparently, than the general culture now finds it worth while to sustain. The end of this semantic fusion is a stock of ideas approximating that of Basic English, with a top-heavy vocabulary that has given up its differentiating function. From a Lowerarchical standpoint (C. S. Lewis), it is an improvement on thought-control; it is thought-atrophy.

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YOU may title this communication: "Etiology of Dorsalgia."

On Sept. 18, 1952, I read an essay by W. D. Grampp (*Sat. Rev.*, 9, Sept. 20 [1952]) decrying the gobbledygook, supererogation, and pleonasm that are the despair of those whose work requires that they read public documents and serious commentaries on public affairs.

How fortunate, I thought, are those of us who read largely in the field of science. But on that same day I read the announcement and rules of the 1952 Social Science Prize in "Association Affairs" (SCIENCE, **116**, 288 [1952]). Oh, my aching back! Even the rules are called "conditions of the competition."

Let me quote from Grampp:

> Finally, there are the cloud-cuckoo words, phrases, and verbal gestures which snatch us off the ground and lift us into a realm of giddy abstractions. Such are "socio-economic considerations" . . . "political and psychological realities" . . . "in the context of dynamic factors." Hardly ever can we know what the user *means* to convey. Almost always can one know what the words *do* convey, which is everything, and therefore nothing. Instead of following the excellent advice of the semanticists, to be-

come more and more specific whenever possible, the employers of cuckoo words become more and more abstract. Onward and upward we are carried until at last we are left floating about a cuckoo-land of verbalisms, flattered perhaps at having risen so high but utterly at a loss to know where we are.

Please, no more "space-time frame of reference" . . . "the manner of theoretical-factual construction that can be studied in the line of progress" . . . "liberation from traditional philosophic-linguistic conventions" . . . "framework of the best-formulated evolutionary naturalism."

These leave me flattered but utterly lost.

AARON APPLEBY

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Destruction of our Cultural Heritage

WITH a widespread program planned or already under way in the vast Missouri Basin, as well as in the Ozarks region of Missouri and Arkansas, for construction of flood-control reservoirs and hydroelectric dams by the U. S. Corps of Engineers, serious thought should be given to a program of scientific research that has as its aim a complete, cooperative study of the historical, archaeological, geological, and botanical resources of the areas to be inundated. There has been no joint scientific study by the interested agencies to determine if these dams are really the most satisfactory and most economical answer to the problem of river control and electric power production. The Corps of Engineers has, in most instances, gone ahead with construction without advice and without the scientific information that is available on the rivers involved.

Science can play an important role in the planning of adequate river control and utilization. For example, Weather Bureau records on the climatic conditions of a given area rarely go back more than 60 or 70 years. Careful examination of available historical documents as to climate and river conditions may carry the record back another hundred years, although such information also is scanty and incomplete. Yet, the rivers in the Missouri Basin and in the Ozarks, such as the Missouri, Osage, White, Current, Eleven Points, and others, have been the scene of human occupation for 10,000 years—perhaps longer. Through archaeological research, information can be obtained as to how these early people lived with respect to the rivers, and how stream and climatic conditions changed and varied over thousands of years. Such information, provided through scientific research, could give river planners a tremendous amount of highly valuable data that cannot be obtained from any other source. To plan the control of a river intelligently, engineers must know how that river has acted and what it has done over as long a period as possible. Yet, under the present system, dams are being constructed and reservoirs are being formed that are flooding the only—and the last—information available as to the past history of these midcontinent waterways. Present river planning is based largely upon inadequate information and guesswork.

In the recently completed Bull Shoals Reservoir area on the White River in Missouri and Arkansas, some 400 archaeological sites were located by scientists from the University of Missouri and Arkansas University. Even this number is little more than a fraction of the total, and only three or four of the known sites were partially excavated. Funds were not available to either university to make a more thorough study of the region. No historical research was done in the Bull Shoals district, and very little botanical exploration. Thus we have an area in the center of the Ozarks, covering thousands of acres, about the prehistoric and historic inhabitants of which we have almost no knowledge. Future archaeological and historical research in the Ozarks will suffer because of this void in cultural knowledge. We cannot go back now and learn more, for the Bull Shoals Reservoir site will be inundated for an incalculable period of time.

With the Congress of the United States appropriating hundreds of millions of dollars for the continued construction of flood-control and hydroelectric dams, some provision should be made for the adequate study and preservation of the archaeological, historical, botanical, and geological records about to be destroyed. One half of 1 per cent of the money spent on the construction of Bull Shoals Dam would have been enough to conduct many such essential scientific studies. And, from such study, it would have been possible for the Corps of Engineers to acquire vitally important information upon the past behavior of White River and to plan the project more intelligently. In addition, Missouri and Arkansas would not today be in the dark as to the ecology of the men, plants, and animals that once lived in the inundated area. Archaeological research, carried on in close cooperation with geological, botanical, and historical studies, can contribute much important knowledge to our present-day planners and to future generations. Only by studying the past can we hope to cope intelligently with the future.

The people of the United States, especially those engaged in scientific pursuits, should exert their influence to see that in future river projects we will not destroy critical relics of our cultural heritage.

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Interrelation of Succinic Acid Dehydrogenase with Apodehydrase and Codehydrase[1]

ALCOHOL dehydrogenase and, as we have found, succinic acid dehydrogenase require for their action the presence of a codehydrase, diphosphopyridine nucleotide. Theorell and Bonnichsen (*1*), working with crystallized alcohol dehydrogenase from horse liver, established that the coenzyme is bound by its pyridine

[1] The technical assistance of Friedrick Roewer is gratefully acknowledged.

ring to a sulfhydryl group of the apoenzyme. In our experience, apodehydrase and codehydrase form an easily dissociatable system. Fully activated succinic acid dehydrogenase from mouse liver is completely inactivated by diluting the liver homogenates twenty times. The reduction of triphenyl-tetrazolium chloride (TTC) to formazan and the reduction of methylene blue to its leuco base were used as tests for enzymatic action. Similar inactivation by dilution takes place in the system alcohol apodehydrase from yeast that had been activated by the coenzyme. The activity of the enzyme that was lost by dilution is again restored to its full value by the addition of excess codehydrase. There exists a dissociation equilibrium between apoenzyme and coenzyme which changes in relation to concentration, and which corresponds to the respective enzymatic activities. Apodehydrase and codehydrase are therefore bound differently than is cytochrome *c* to its complementary protein (*2*).

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References

1. THEORELL, H., and BONNICHSEN, R. *Acta Chem. Scand.*, **5**, 1105 (1951).
2. THEORELL, H. *Biochem. Z.*, **301**, 201 (1939); THEORELL, H., and AKESSON, A. *J. Am. Chem. Soc.*, **63**, 1804, 1818 (1941).

An Index of Educational Qualifications of a Faculty

SEVERAL years ago the writer compared the formal educational qualifications of the faculties of corresponding departments of two similarly organized colleges during the preceding decade. From a study of data compiled from catalogues and bulletins issued by the two institutions, it was apparent that the formal educational qualifications at one college were superior to those at the other, but the comparative trends at the two colleges were not so evident. In an attempt to show the comparison more clearly, two indexes (Table 1) were tried.

TABLE 1

INDEXES OF FORMAL EDUCATION

(B = bachelors, M = masters, D = doctors)

$$4\text{–}5\text{–}7 \text{ Index} = \frac{(4B + 5M + 7D)}{7(B + M + D)} \times 100$$

$$1\text{–}2\text{–}4 \text{ Index} = \frac{(1B + 2M + 4D)}{4(B + M + D)} \times 100$$

The 4–5–7 index is based simply on the total number of collegiate years generally required for each of the three academic degrees, but, in order to give more weight to advanced degrees, the 1–2–4 index was tried. Qualitatively, the comparison and trends were similar with both indexes, but the 1–2–4 index brought them out more clearly. Consequently, and for the sake of brevity, only the 1–2–4 index will be considered here.

Since the data used in the study were unofficial and were subject to some error in compiling and processing, assumed data will be used for illustration. Accordingly, synthetic data for corresponding departments of two hypothetical colleges are given in the first four columns of Table 2. For both departments the resulting calculated 1–2–4 indexes are shown in the fifth column.

TABLE 2

FORMAL EDUCATION OF TWO FACULTIES

Year	Bachelors	Masters	Doctors	1–2–4 Index
	College 1, Department X			
1937	1	6	10	77.9
1938	0	6	11	82.3
1939	0	6	12	83.3
1940	0	6	13	84.2
1941	0	5	13	86.1
1942	0	4	13	88.2
1943	0	4	13	88.2
1944	0	3	15	91.7
1945	0	3	16	92.1
1946	0	3	16	92.1
	College 2, Department X			
1937	3	5	6	66.1
1938	3	5	7	68.3
1939	2	6	8	71.8
1940	2	6	9	73.5
1941	2	5	10	76.5
1942	2	5	8	73.3
1943	2	6	7	70.0
1944	2	7	7	68.7
1945	2	8	7	67.6
1946	3	8	6	63.2

The data given in the first four columns of Table 2 show that formal educational qualifications at College 1 are superior to those at College 2. A brief inspection of the calculated 1–2–4 indexes given in the fifth column of Table 2 will serve to show clearly the trends at the two colleges and the comparison between the trends. These relations are shown more concisely in Fig. 1.

In this paper, the expression "formal educational

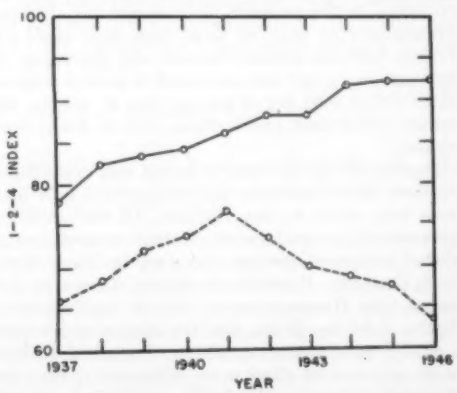


FIG. 1. 1–2–4 Indexes of formal education: solid line for Department X of College 1; broken line for Department X of College 2.

qualifications" is used to denote academic training in the field being taught. It is recognized that other forms of professional training constitute valuable qualifications of a teacher. Be that as it may, the formal educational qualifications index is offered only as a measure of the pertinent academic training of a college faculty. As used in this paper, the index does not take into consideration academic training in excess of the requirements for a lower degree but insufficient for a higher degree. Such training could be recognized by using appropriate fractional values.

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Book Reviews

An Explorer-Scientist's Pilgrimage: The Autobiography of William Herbert Hobbs. Ann Arbor, Mich.: Edwards, 1952. 222 pp. Illus. $3.75.

The reviewer has often tried to figure out what a well-matured man was like when he was a lad. This book answers the question effectively for one. The reverse question has also been pondered. What will the student of today be like when he is 60? 80? 90? If Dr. Hobbs' tutors ever let their imaginations thus wander they will be interested in reading this satisfying story!

Dr. William Herbert Hobbs studied at four universities, taught at three, and lectured at many. Some of these contacts were important in his development, but the contacts with men were more valuable than those with institutions.

As the title suggests, Hobbs was a traveler—particularly a geologic traveler—and an observer-student. He visited Europe several times, Africa twice, the Pacific Islands, Japan, Australia, New Zealand, the Hawaiian Islands, Greenland several times, and apparently most of the United States, always with his eyes open to minerals, rocks, and geologic phenomena. He became an authority on earthquakes, volcanoes, and glaciers, and his more than 400 articles and 15 books show his magnificent range of interest and scholarly approach to the problems that caught his attention. Translations of some of these have been made into French, German, Italian, Spanish, and Rumanian. He met men easily and was privileged to possess acquaintance with a long list of leading men in science, education, government, and business, both in America and abroad.

Besides all his valuable personal and institutional contacts, there have been the projects and field problems with which he has wrestled. All have been important in his development. Hobbs' research has included volcanoes, present and past, in Italy, Greenland, Germany, Parícutin in Mexico, Lassen in California, and Halemaumau in Hawaii; earthquakes in Spain, Calabria, Malta, and the eastern and western United States; glaciers in Alaska, Greenland, Switzerland, and ancient glaciers in Wisconsin, Iowa, New England, and the scablands. He has studied and written upon arctic and antarctic problems. After careful study of maps and literature he has presented new interpretations of several exploratory journeys by others. He has made great contributions to the problem of winds on Greenland's icecap, and on continental glaciers.

The book should be read by young scientific aspirants and by any who doubt the value of environment and contacts or the reaction of native ability and application to environment.

GEORGE D. HUBBARD

279 Oak Street, Oberlin, Ohio

Intermediate College Mechanics: A Vectorial Treatment. Dan Edwin Christie. New York–London: McGraw-Hill, 1952. 454 pp. $7.00.

With the emphasis of present-day mechanics on vectorial methods, it might be considered too much to ask that a completely adequate treatment of the analysis involved could be incorporated in a text on intermediate mechanics without, at the same time, obscuring the physical principles involved. Too often, the college junior, in his preoccupation with the complexities of the vector mode of treatment, sacrifices physical understanding to mere manipulation of symbols.

As a vectorial treatment, Christie's book provides a well-consolidated body of physical material, while still presenting the requisite mathematics in some detail but without undue prominence. Each concept has been given careful attention with regard to illustrative examples and has, on the whole, been complemented by a set of well-graded exercises.

In the arrangement and development of the text, the author largely follows the standard pattern of procedure. The notion of force, encountered after the preliminary treatment of vector algebra, is taken up from a semi-intuitive point of view. With the statements of Newton's three laws, the analytical basis for statics of a particle is established. The case for equilibrium of rigid bodies follows in the very lucid chapter on couples and moments.

Time, the "third basic ingredient of mechanics," is added next. Here the student is introduced to the fundamental nature of vector rates of change. The author very skillfully keeps the purely formal aspects of the analysis subordinate to the principles embodied in their formulations. The logical development of the kinematics of a particle and of rigid bodies follows,

yielding the usual expressions for velocities and accelerations.

In the treatment of dynamics and "energetics," there are many points of pedagogical merit. Having introduced the concept of mass and the vector formulation of the second law, the author deals with motion relative to a noninertial system of reference. In this the resultant force acting is reinterpreted to include "frame" and Coriolis forces—the presentation of this artifice being direct and appealing and not having the vague touch of mystery engendered by the use of the term "reversed effective."

The development of work and energy principles is more or less standard in approach. Here again the coherence of text, examples, and exercises, and their orientation with respect to preceding work, are explicitly brought out.

It is not until the time integral of the principal equation of dynamics is treated that the second law of motion is given in general form. Logically this arises as a natural outcome at this point. Little attention, however, is given to this form as such: rather, the impulse-momentum principle is preferred.

The more sophisticated ideas of force fields, with the concomitant utilization of vector operational methods, appear in the final chapter on rigid mechanics. The approach again is purely functional, since two of the final chapters of the text are devoted to rather concisely analytical expositions on the mechanics of deformable bodies and of ideal fluids. A brief treatment of one-dimensional wave motion and kinetic theory constitute the final chapters.

H. R. Milley
Department of Physics, Purdue University

The Lipids: Their Chemistry and Biochemistry, Vol. I, ***Chemistry.*** Harry J. Deuel, Jr. New York–London: Interscience, 1951. 982 pp. $18.50.

The great mass of knowledge already accumulated, and the accelerating flood of information being published, have made it difficult for the specialist in any one of most fields to keep in mind the innumerable facts of pertinence in that field, and have made it impossible for most scientists to be versed to their own satisfaction in related fields. To mitigate the difficulty, there is fortunately an increasing number of periodic reviews, comprehensive symposia, and monographs.

Professor Deuel, well known for his many contributions to the biochemistry of the lipids, has undertaken the formidable task of preparing a compendium on the lipids. In this volume he has assembled the information on the chemistry of the lipids in an admirably organized way. The biochemistry of the lipids is to be the subject of Volume II.

The author has covered the area so intensively into 1950 that most individuals, even specialists, will find practically everything they desire, and the extensive bibliography of over 3500 citations will certainly, in most instances, make possible the convenient location of any available additional information sought. The lengthy table of contents provides an outline of the material covered and will usually lead at a glance to any desired topic. The text itself displays this carefully prepared outline by the use of typographically distinct headings, subheadings, etc., facilitating the location of desired information. The index has been most exhaustively assembled, approximately a sixth of the total pages being devoted to the indexes of authors, subjects, and plant and mineral sources of the lipids.

Extensive discussions are included of all the well-known and apparently of the other less well-known simple, compound, and derived lipids. Each substance is discussed with respect to provenience, isolation, purification, and physical and chemical properties, including methods of preparation. Physical properties are correlated with chemical nature. Solubilities, melting points, boiling points, and spectral behavior, for example, are considered in detail with respect to structure of the various types of fatty acids. Among the many topics discussed are crystalline habits and polymorphism of the fatty acids, analysis of fats, constants used in identification of fats, oil and fatty acids, interesterification, inhibitols and antioxidants, chromatographic separation, including an admirable concise presentation of the theoretical basis for adsorption phenomena, stereoisomerism of the carotenoids and vitamins A, activation of provitamins D, and biological activity in relation to chemical structure of vitamins E and K and related compounds. Every topic, in fact, that could be expected is treated in adequate detail, and every constituent of living tissues, insoluble in water but soluble in fat solvents, or related to the accepted lipids, is discussed.

Structural formulas are generously employed, with very few detected errors; 102 figures and diagrams are included. Of the 204 tables, some are taken from or based on tables of other authors, but many have been newly prepared.

Biochemists, and all others whose work relates to the constituents of living tissues and their functioning, will find this a valuable source of ready, comprehensive information on the chemistry of the lipids, and many will find this an indispensable addition to their personal libraries.

Ralph C. Corley
Department of Chemistry, Purdue University

Morphogenesis: An Essay on Development. John Tyler Bonner. Princeton, N. J.: Princeton Univ. Press, 1952. 296 pp. $5.00.

The problem of development of form has been variously considered by many individuals, most of whom become bewildered by the multiplicity of types and by the inadequacy of any generalization to explain the many differences. Most biologists accept form without thinking of it as one of the fundamental problems which every living thing must solve in its own peculiar species' way.

In the search for a single generalization to cover all the contingencies of the three fundamental construc-

tive constituents of living systems, Bonner invokes the ultimate microconstitution. Biologists always manifest an unusual penchant for hoping that chemists and physicists will promote their fields to the clarification of biology. When the biologists think usefully in precise instead of generally descriptive analogies, the significance of chemical and physical fundamentals will be biologically applicable. Bonner has considered selected morphogenetic examples from the entire biological field. He has stressed the cardinal factors which focus attention on the development of form. Although he may be accused of superficial treatment, he has picked his materials wisely.

The provocative points revolve around oversimplified definitions and bring to our attention our own shortcomings in this regard. For example:

> Growth is the increase in size in living matter, involving the intake and storage of energy by new protoplasmic synthesis. . . . Morphogenetic movements are migrations of the protoplasm without synthesis of living materials. . . . Differentiation is an increase in the detectable differences in chemical composition (resulting from synthesis) of parts of an organism which occurs between one time during development and another time.

It is not fair to remove these passages from context. There is in most cases sufficient textual amplification to give a much better picture than expressed here, but the primary definitions should carry a greater degree of precision than is expressed.

The discussion of size and pattern is illustrated mainly by plants. The analogy with crystals, with a clear consideration of surface-volume relations, serves as a fitting interlude for the discussion of physics and chemistry in development. The complexity of the energetics, as Bonner points out, will not of itself explain development. Other physical aspects, such as surface tension, crystallization, or diffusion, are considered as possible parts of the picture of change. Their possible nature in the living system is discussed. This is subject, of course, to the necessary modifications imposed by the biological system, which seems to have an unerring way of never being as completely dependent upon the physical conditions as we would like to have it be. Growth in all its diversity has been discussed. The problems of intrinsic control, genic control, hormonal control, and internal configuration are all touched upon. The logical conclusion is evident that we do not know how the genes and the protoplasmic components manage to create the perfect pattern of growth.

The succeeding chapter deals with the patterns of morphogenetic movements. The synthesis of descriptive reactions moves smoothly through the entire first part, which deals with plants, but as we turn to animal development the picture is not nearly so sharp. The tendency is to accede to a much simpler formalization of vertebrate eggs than is at present possible. Much study will be necessary before the reactive components can be isolated and their relative import on development known.

When the discussion comes to patterns of differentiation we find that "differentiation" is used without any specific reference to the structure involved. The pattern is different from the process by which it has become a pattern, a resultant determination without process of becoming. In attaining differentiation we again must consider the multiple factors that are at work. Bonner points out that there are different levels of differentiation, which may be arrived at independently—although not necessarily so. It is a corollary to this that the pattern of differentiation may also follow a like rule.

Bonner deserves our thanks. He makes no pretense of giving the answer to the problem of form. He has, however, placed it succinctly before us and has focused attention on what we do not know but need to know before a more definite answer can be given to the significant factors underlying the formative pattern of development which results in the specific form of the organism.

JOHN S. NICHOLAS
Osborn Zoological Laboratory, Yale University

Scientific Book Register

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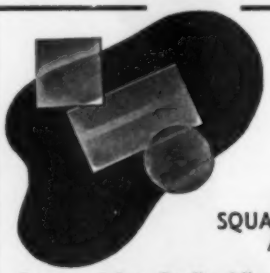
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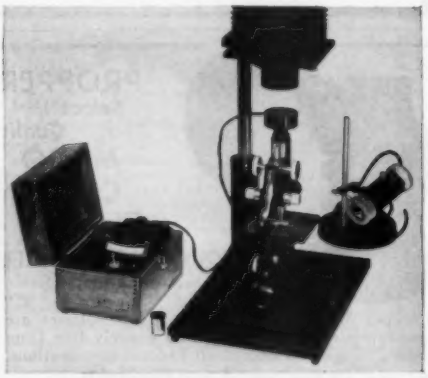
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